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SIR CHARLES FOX.

JUST five and twenty years ago the Great Exhibition of the Arts, Manufactures, and Industry of all Nations, was opened by Her Majesty under auspices of the most brilliant character. The scene has never been repeated. The success of the entire arrangements surpassed all expectation, and the profits formed a fund that remains an annual revenue to the cause of Science and Art for all future generations. The novelty of the enterprise caught the sympathies of the scholar, manufacturer, and spectator; and the practical phase enlisted the emulation of every class in the provision of articles and works: an emulation that had reference to making the whole collection a fair display of what could be done, and what was actually being done, not only in this but in all other lands.

But the effect was greatly augmented by the novelty in architecture of the building containing those treasures, and it is fitting that we should honour the men whose genius and resources provided so magnificent a spectacle. Sir Joseph Paxton and Sir Charles Fox were the practical men whose combined labour evolved a scene that, as we have said, has never been repeated, and which, considering all the circumstances, can never recur. We, therefore, use the occasion wisely in offering our readers a brief outline of the career of the engineer whose portrait stands at the head of this paper.

Energy is correctly defined as obedience to the words of Solomon, the preacher-king, "Whatsoever thy hand findeth to do, do it with thy might." It is the result of a man's undertaking to do exactly what his faculties prescribe as his calling; and his doing it with "his might" is the simple result of having pleasure in his labour. The manufacturing districts abound with men of this type: men who would not be anything but what they are upon any consideration; men who are proud of their vocation, and for whom its rough necessities and intense labours have a charm unknown to many provincial communities; men who glory in attempting to accomplish the very uttermost that their brains, opportunities, influence, and credit can seize and overcome, notwithstanding all difficulties. In such a field many a one gets a "cropper," but if he be a brave man he is up and in the race again little damaged. His resources are chiefly personal, and all outside him is so much material; therefore he is daring, free, and often wins gloriously after the most terrible catastrophe. Energetic men bear about them an atmosphere of enthusiasm, and all who come within their range are sure to inhale some of its vitalizing properties. It can create places like Barrow-in-Furness out of the very earth its keen perception may select as fitting. It can spread abroad its area like Birmingham, and make men quite as proud of coming from "Burmingham" as they are of being Englishmen: and when the grand old modes of doing, making, constructing are found insufficient, it can invent ideas too large for the present, and ripen them by their foresight against the time when they will be required. Of such characters Sir Charles Fox was an example and an illustration.

The town of Derby has the honour of being his native place, for he was the youngest son of Dr. Fox, an eminent physician there. He was born on the 11th March, 1810, and educated in the ordinary way of the middle and professional classes at that time in his own town. He originally intended to tread the way his father trod, graduate as his assistant, become his partner, and, in the end, step into his professional position just as a matter of course, had the art and practice of medicine been one congenial to his tastes and inclinations, which did not happen to be the case. In that midland town he had caught the infection of his surroundings, and the result was the development of a mass of his early self-chosen employments into a determination to quit the healing art and try his fortune at the constructive ones, for he saw, as all around him saw, that he possessed rare mechanical skill. Before his marriage he had left home to join himself to the celebrated Swedish engineer, John Ericson, of Liverpool, by becoming an

articled engineer, whom he assisted in several of the great works that were originated and demanded through the introduction of railways; and his first distinctive mark appears to have been in taking part at the trial of speed of locomotives at Rainhill, on what was then called the Birmingham and Liverpool Line (now incorporated in the London and North Western scheme), and at this celebrated competition the fact was revealed that a locomotive could attain a speed of fifty miles an hour. Of course Stephenson witnessed and took part, and on Fox becoming acquainted with him, Mr. Robert Stephenson made him overtures that were acceptable, and placed him on the works he was then constructing for the Birmingham and London line of the same system; of which he was the chief engineer, his statue now adorning the station at Euston Square. His first "bit" was at Watford, and he performed his engagement so well as to be intrusted with the augmentation and arrangements of the works at Camden Town on the same line. We know what prodigious labour had to be done in shaping such a place to its great design; and how ably it had been done is evident from the little change that it has since undergone, beyond increase from time to time. These arrangements included the works from Camden Town to Euston Station—works constructed at a time when there was little or no experience on record to guide or to teach, but which stand now unaltered. Stephenson, of course, is entitled to the praise, but the choice of this young man as his "sub," and the successful ending, must cast a ray of its glorious honour upon the name of Fox as of all else who shared therein.

While residing at Gloucester Place, Camden Town, and engaged in the works above named, Mr. Fox discovered a better way of shifting carriages and trucks from one set of rails to another. The original method had been to place them on turn-tables, a most tedious process, but then held to be sufficient. However, as the business of railways and all the calculations belonging thereto amazingly surpassed all expectation—the lines costing more by hundreds of thousands, but the revenue that should have been £60,000 turning out to be £260,000—the tremendous rush for means of transit caused confusion from the want of facilities. In 1838 Mr. Fox took out his first patent, entitled "An improved arrangement for rails for the purpose of causing a railroad engine to pass from one line to another," or as he describes it, "Such an arrangement of rails, where it is required to have crossings or turnouts on to sidings, as will prevent the wheels or the carriages, engines, or machines, or trains used thereon from getting off the lines they are intended to run upon, and whereby the whole of the main line may always remain a fixed line." We need not give a description of that which we all see at work at every railway station and terminus in the kingdom, but simply state the fact that he was the inventor of the Safety Switch.

But Fox determined to enlarge the scope of his operations. He would not confine himself to railways and their construction, but sought a field to develope his mechanical genius. His work had prospered; he had acquired money and a good name in his profession, which made him a desirable auxiliary wherever he might choose to go, or in whatever department his mind preferred. We find him entering into partnership with the renowned house of Mr. Bramah at Birmingham, where he became partner, and the firm adopted the designation of Bramah and Fox. This position was more to his taste, involving, as it did, great works, but with much scientific detail, and affording a field for all the appliances of an inventive mind. Mr. Bramah had had a career of honour from the beginning of the century, and had reached a good age when Fox joined him. At his death the whole concern devolved upon his junior, who in seeking for capital for so great an undertaking took into partnership an indefatigable worker of kindred spirit—Mr. Henderson, and the firm became "Fox, Henderson, and Co., of London, Smethwick, and Renfrew," but the new inventions Fox produced were reserved for his own advantage.

The art of manipulating iron had made great progress, but his experience taught him that in shearing, cutting, and punching metals further change had become necessary, and in 1846, at his London works, Birmingham, he took out a patent for "Improved machinery for shearing, cutting, and punching metals." The operation had hitherto been done by means of a kind of die-press, but the work did not come out clean and perfect. He therefore wrought out a method of working the dies by a different construction of the press and the die-holders, that successfully simplified the process and effected a better finish at a decreased labour charge.

Then, again, engineers were exerting themselves to improve the process of welding iron and steel, and Mr. Fox took out his patent in 1847, which he entitled "A method or methods of uniting pieces of metal together, and of pressing or forming pieces of metal into various forms and shapes useful for welding tires of wheels, for welding a faggot or pile of iron or steel used in making axles or shafts, and for making spokes of railway carriages." The machine itself was not new, but the method of manipulating the iron or steel was.

In addition to this a very short time afterwards he took out another in connection with that, which is entitled "Improvements in the construction of hydraulic presses, such as are used in the manufacture of articles made of iron, steel, and other metals, &c." The compression and ejection of water were expedited by using separate reservoirs, giving to the press vacuum chambers for certain purposes and furnishing small extra chambers by hydraulic cylinders to be used in various ways therein specified.

Immediately on this we find him returning to his former studies by securing legal protection for "Improvements in the permanent way of railways and in carriages to be employed on railways; 1st, by making the permanent way of double instead of single rails; 2nd, in the mode of constructing 'switches' for the permanent way; 3rd, in the method of securing railway 'chairs' in their proper position; 4th, in the mode of constructing railway carriage wheels with flanges projecting from the middles of the tires; 5th, in constructing the axle-boxes of railway carriages and their proof-boxes; and 6th, in the mode of inlaying or introducing hard pieces of metal into the threads or bearing surfaces of the tires of railway wheels."

This venture proved a great success, bringing fame and profit. "Fox's Safety Switch" soon became familiar to the railway world, and enlarged the inventor's connection and influence. The difficulty overcome by the adoption of this contrivance had long been felt, and efforts had been made in the same direction by others; its introduction received a hearty welcome, contributing as it did to the public safety and the convenience of the general business. In connection with it, and at a few months' interval, Mr. Fox joined Mr. J. C. Haddan of London, in a patent entitled "Improvements in railway chairs, in trenails or fastenings, and in machinery for preparing railway sleepers." The addition of this conferred a further obligation on railway directors, because the previous inefficiency of the methods employed to preserve the wood from the effects of climate and exposure greatly augmented the annual charge for repairing the permanent way, a charge that could not be carried to capital account but must be debited to profit and loss; thereby directly affecting the shareholders' dividends, and incidentally increasing the general probabilities of accident and liability for compensations.

Having now disposed of the list of inventions, we enter on a notice of the great practical work with which his name will for ever be associated, and on account of which he acquired the Royal recognition of knighthood: we refer to the erection of the Crystal Palace in Hyde Park for the Great Exhibition of Industry of all Nations in 1851.

Previous to that date there had been many isolated exhibitions, notably in Ireland, in the West of England, in the middle and northern towns likewise, and in foreign lands a similar custom had begun to prevail to the advantage of culture and the augmentation of manufacturing industry. London had been the exception; but London and the country began to express their dissatisfaction that the metropolis, with all its singular facilities for intercourse with every part of Great Britain, should not render this service to herself and the nation she represented. These murmurings brought forth many suggestions, and the public mind settled into a resolve that this isolation should cease and the capital of the kingdom should accept her responsibilities. Accordingly in January, 1850, a Royal Commission received instructions to consider the various schemes and ideas afloat in the community with a view of satisfying the general desire to see a collection of specimens and implements, of material and manufacture, of skill and art gathered together in one place, for the purpose of developing and revealing the national material and the national capacity engaged in the countless forms of British industry, taste, and power. This Royal Commission received a suggestion from the late Prince Consort that such an exhibition need not be confined to the revelation of what Great Britain could do and did, but that it would confer a great benefit to our countrymen, who are generally absorbed in their own affairs and doings, and who neither knew nor wished to know what competition and skill had been successfully engaged in effecting for other lands if an exhibition were opened to which all nations might contribute. England might prove to herself that her own claim for superiority was an affectation that not only fed conceit, but incurred the danger of presently affecting her labour market, unless her goods could at least equal the average standard in form and utility. With the candour of the English character, it is not surprising that such a suggestion received a hearty welcome, and the public came to the resolution of making it a thoroughly national undertaking. To verify its intent the

whole land formed itself into local committees, whose first duty should be to provide a guarantee fund sufficient in amount to provide against such a contingency as failure arising from the receipts being inadequate to the expenditure, and thereby necessitating a call upon Parliament for a government grant. This did not take many weeks, for the enthusiasm became contagious, and towns and individuals emulated each other in providing the stake, determined that the self-reliance of the national character should under any circumstances have a thorough vindication. The sum guaranteed amounted to £75,000.

The next step was the appointment of a building committee, consisting of the most famous architects and engineers. These gentlemen had a good perception of the greatness of the enterprise, and at once prescribed that the size of the building should be adequate; but they were met with the difficulty of site. Ultimately it was decided that an unfrequented part of one of the royal parks would be the best position, and notwithstanding a little popular clamour their point was carried, and Hyde Park was the chosen spot. In a very loose prospectus they invited plans from all the world for such a building, and to their amazement and dismay some 240 were sent in by the appointed time. Favourable reports were returned as to five of them, and an approval of 18 more; but the public judgment did not accept their decision, and the committee framed one of their own, and a most hideous thing it was. However, tenders were invited for a brick building upon their design, and contractors busied themselves in their preparation. Still the public looked coldly upon the position of matters so hopefully entered upon, and among the disaffected was Mr. Joseph Paxton, the horticultural contractor of some magnificent conservatories, notably that of the Duke of Devonshire at Chatsworth, at which place he was also the gardener. The idea occurred to him that seeing the popular distaste at the idea of millions of bricks being deposited in Hyde Park, and the very just apprehension that they might probably remain there, a structure such as he had been in the habit of erecting, or rather designing, would be acceptable; and he hastily, after the final day had passed, made a rough sketch, which he ventured to submit notwithstanding that circumstance. He happened to be coming to London on that business, and Mr. Robert Stephenson, one of the committee, occupied a part of the carriage. To him Paxton unfolded his plans, and his friend instantly perceived that the public jealousy would be extinguished, and the charm of novelty restore confidence; he eagerly listened and became convinced of its adaptation and efficiency. To meet the difficulty as to time, he arranged to obtain a few days that proper plans might be sent in before the final contract should be signed. His colleagues accepted the condition, and Paxton hastened home, went directly to Mr. Fox, who understood that kind of architecture, and Fox went to work night and day for seven weeks, taking but six hours' rest each day, and completed the plans within the specified time. They came up to London, met the committee, and on the 19th July the design of Paxton and the plans of Mr. Fox were sent in and verbally accepted, accompanied as they were with tenders on the 16th of that month. On the 26th the site passed into the hands of the contractors, Messrs. Fox, Henderson, and Co., under the seal of the commissioners appointed by the Queen, by which they undertook the work at £79,800, a sum but little beyond the public guarantee.

At the anniversary meeting of the Derby Mechanics' Institute in September, 1850, and also before the Society of Arts, Mr. Paxton gave some very interesting particulars concerning the origin and progress of the undertaking.

"When the six eminent architects and engineers were selected as a committee to choose a design, I had no intention of offering one, for I took it for granted that something worthy of the occasion and the nation would be selected by them. When the time approached for the production of the plans, there was a discussion in the newspapers as to the design best adapted, and the sketch I saw in the *Builder* did not inspire me with very exalted notions. I was with my friend Mr. Ellis at the House of Commons when the idea occurred to me to send in a design." After further conversation, Mr. Paxton engaged to send in his plan within nine days. "On coming up, Mr. Robert Stephenson happened to be in the train, and he was one of the building committee." Mr. S. minutely examined the plans, and exclaimed it was just the thing. The design was accepted on the 16th, and the contractors had possession on the 26th July.

"I was on the ground last Saturday, and saw two columns eighteen feet high and three girders put up by two men in sixteen minutes. That would give some idea of the rapidity with which the work was progressing. It is pleasing to know that such things can be done at the present day. But when I tell you that the whole of the columns are fitted together like the joints of a telescope, and formed in the same mould, and put in sockets to receive them, and then fastened with bolts, your surprise at the huge design will give place to astonishment at the simplicity of detail, and the admirable nicety with which one part is made to tally with the other. The town of Derby must feel proud that it has produced a man like Mr. Charles Fox, the contractor for the erection of this building. Without the aid of a man of equal energy and talent, it is almost impossible that the building could be completed in time. The systematic manner in which Mr. Fox's establishment is conducted, combined with that gentleman's personal superintendence of the erection of the structure, renders me confident of its completion within the allotted period. The other day Mr. Fox was upon the ground from seven o'clock in the morning until ten at night, and I believe he will continue to devote almost the same number of hours daily until the work is done. In short, the manner of his proceedings is in the highest degree satisfactory, and it affords me infinite pleasure in doing justice to him on this occasion."

Nor is this praise unmerited, and we repeat that any one may read the details of that marvellous effort of contractor's resources, but none can read it without admiration. Papers are handed over to Mr. Fox, and he accepts them: these are the designs of the architect. All he has to do with them is merely to cast them out, find the materials required of the adequate size and quality, and put up the structure by a given date. Manifestly there had been no previous experience, for the idea came before the world as a startling phase of the time. Sir Joseph, then Mr. Paxton, had designed iron and glass structures in many places; but here was one covering seventeen acres of ground. The contractors took it in hand to do—he could design, but they had to create, and under what conditions? London had been alarmed at millions of bricks being put together in a public park, and nothing could appease their jealous fears about a permanent interference with its open spaces: the committee would accept Mr. Paxton's scheme only on the condition that no bricks were used beyond such as might be required for drainage, which would be below surface. Mr. Fox worked upon the ground, and undertook the erection on that stipulated restraint. Well, he had only one available plan, that was to construct the edifice as we do scaffolding, in given areas as nearly square in idea as possible, because that form admits of multiplication to any extent, and is safe, whether limited or unlimited. He divided the space into squares, perfectly geometrical, of 8 ft. each, which would give 231 squares in the length, and fifty-one in the width for the whole building. The central aisle had to be 72 ft. wide (nine squares), and the transept, being the entire width of the structure, must be of the width in itself of the central aisle. By thus reducing the space to equal parts, hundreds of material, whether glass, iron, or sashes, could be ordered with a certainty of their perfect combination when brought together. Then, of the galleries the same multiplication of given lengths facilitated the preparation of the parts almost inconceivably. Columns, trussed girders, rain-water pipes of cast iron; ties for the trusses, bolts, rivets, screws, and nuts of wrought iron; gutters, ridge pieces, frame ribs for roof of transept; sham trussed girders, flooring, &c., of wood; and skylights, side "walls" in transept, aisle, and galleries, as well as outside, all glass; these could be, by division of labour and orders, all brought together from forty places with a certainty of their fitness, being made to a given size, which given size governed every detail in the construction. Here is seen the genius of the contractor; his power of overcoming all difficulties. Nine months is not long for so vast a result to be attained; but Fox did it. How? Probably he could scarcely tell. He had to construct machines of all kinds to facilitate laborious processes. Waggons for glazing, machine for finishing sash-bars, another for cutting the gutters, a circular planing machine, besides the ordinary application of steam in planing and chipping, and contrivances of various kinds were put up in a few days and set a-going. Then his own works were not enough; works had to be taken in London, and kept solely on the preparation of material such as by planing or other special work. And at Birmingham, Messrs. Chanies' large company was pressed into the service, and Tupper for the galvanized iron. But what struck Prince Albert specially was the extraordinary resources Fox brought to bear in setting up the massive circular ribs for the roof of the transept. In forty-five minutes a pair of them were got up to that alarming height, and vaulting over the old trees on the ground excited the admiration of all the spectators, for not a bough had to be cut. The huge frame sprang 120 feet from the ground, and then the glazing went on immediately. We cannot give space to revive a scene now quite in the past, but the impressions then raised of the illimitable resources of an energetic engineer are not likely to be obliterated by time.

The enormous labour and skill may be perhaps better realized when we give a rough idea of the materials employed. Of iron columns, 20 ft. and 24 ft. in height, there were 3,300. For base pieces beneath these columns, on which the whole structure rested, there were 1,074. Of girders, three different lengths, 24,

48, 72 ft. length respectively, of five different weights, 12, 13, 35, 120, and 100 cwts., there were 3,500, making 4,000 tons. Of Paxton gutters 30 miles. Of glass, in sizes that could only be made in England, there were 17 acres in the roof, beside 1,500 vertical sashes glazed for the sides. Of wood for galleries and floor, 1,000,000 sq. ft. for flooring alone. Of sash bars 200 miles. The woodwork required altogether 6,000,000 cubic ft., and in the construction 1,800 men were employed. Surely this may be said to have been a practical undertaking for one firm to have in hand. Besides all these, the contractors, after the building was finished, undertook the construction of stalls, counters, and the unpacking of goods.

Sir Charles Fox became a member of the Institution of Civil Engineers in 1839, and contributed very freely the results of his study and experience from that time forward for thirty years, on several subjects of general utility, such as the treatment of iron, the construction of bridges and their foundations, the temperature of mines, the mechanics of girdles, the rolling and locomotive stock of railways, the principles of roofing in iron, the materials for iron rails in permanent ways, the relative power of steam-engines, the formation of docks, the theories of telegraph cables, and kindred subjects. These communications are here summarized.

In 1843, Feb. 14th, Mr. Clay, of the Shirva Works, Scotland, introduced his process for making wrought-iron direct from the ore in six processes :—1. Calcining the ore. 2. Smelting in a furnace with cold or hot blast, coal or coke for fuel, and limestone as a flux. 3. Refining the pig into plate iron. 4. Puddling, shingling, and rolling to produce No. 1 bars. 5. Cutting up, piling, and rolling to produce No. 2. 6. Repetition to make best. This method found acceptance, being a scientific treatment of ore to produce malleable iron, and intended to relieve a large portion of the capital sunk in constructing blast-furnace blowing-engines. It would seem that the ore had to be a selected mixture of Scotch and hæmatite, but as Faraday said, the process was founded on scientific principles. Mr. Fox had used some of the product with severe tests, and found it equal to the best cable bolt made in a much more laborious and expensive way. This was one step in the improvement of the manufacture of steel, which, after another dozen years, Mr. Bessemer effected in a thorough and lasting process.

Then, at the important discussion in March, 1853, upon Fairbairn's experiments on Calvert's method of strengthening cast-iron by the use of an improved coke. These experiments arose from the gradual decadence in the quality of iron having alarmed the engineers; who, observing that the force of competition deteriorated the article, sought by science to improve the quality without enhancing the cost, and this view had Mr. Fox's support, for, especially in rails, as Mr. Brunel said, this race about price had become a source of danger.

Messrs. Fox, Henderson, and Co. having constructed two large iron roofs—then a novelty—one at Woolwich Dockyard, at the building-slip No. 4, 84 ft. span, and another of 136 ft. span for the Lancashire and Yorkshire Railway in Liverpool, the details of the working drawings and dimensions formed an item in the discussion of Mr. Phillips, descriptive of the iron roof for the joint station at Birmingham, at the civil engineers' meeting on Jan. 30, 1855, when Sir Charles Fox said he found roofs of 50 ft. to 60 ft. span were practically the cheapest; for although, below that size, there might be an economy in the weight of iron, still, the cost of labour and of the covering for a smaller roof were nearly the same as for a larger span, and having more ridges and sky-lights, it became actually more expensive; but when the dimensions were extended, the circumstances were changed, and the increase in the weight of the iron became a matter of importance. For practical reasons he preferred, therefore, a span of 50 ft. to 60 ft. to any other dimensions. He then quoted instances showing it might be often the more economical size. The discussion then went on to the subject of galvanized iron, when Sir Charles said he had considerable experience in the use of galvanized iron, and did not remember any instance of a failure having taken place when the process had been well performed. He had expected to find some difficulty with the roofs constructed by him at Pembroke Dockyard on account of its exposure, not only to the sea air, but the spray in heavy weather; but there had been no failure in those roofs. The question of the duration of galvanized iron was one to which he had devoted much attention. It appeared to be a singular theory that, by coating iron with a more readily oxidizable metal, the oxidation of the base could be prevented; but yet such was the result of galvanizing. The principle of galvanism did not actually come into play until some portion of the zinc covering had been removed. If a sheet of iron was exposed to moisture it absorbed oxygen, and a peroxide was formed on the surface which would go on extending until it would absolutely exfoliate; whereas, if zinc was exposed in the same manner, though it also absorbed oxygen, and became covered with a protoxide, it did not appear to extend, and actually required some considerable force of abrasion to remove it; this property enabled it to protect from oxidation the surface of the iron which was used for coating. The protoxide did not absorb the carbonic acid from the atmosphere. Subsequently the discussion turned on the cost of roofs, and Mr. Henderson gave a long detailed statement of the various methods and rates of cost.

In May, 1851, Mr. Hughes read a paper on the "Pneumatic method of constructing the foundations of the new bridge across the Medway at Rochester," which bridge was then in course of erection, under the direction of Mr. Cubitt, by the contractors, Messrs. Fox, Henderson, and Co. The description of that work would form a portion of an article on bridges, but is here too long. Sir Charles Fox, in the discussion, informed the members that the saving effected by his method was enormous, amounting to nearly all the cost of the temporary works. In the estimate for the new bridge, which was intended to have been built upon stone piers and iron arches, the cost of cofferdams alone was set down at £53,000, and that of the piers and abutments at £25,000; but by this method the piers were completed to 4 ft. above the water at a cost of only £23,000. To each pier there were fourteen cast-iron cylinders, two of which were placed singly, and the other twelve in pairs, with a plinth-plate of a cutwater shape overhanging them to a distance of 4 ft. The price of the cylinders, 6 ft. in diameter, was £10 10*s.* per ton, those of 7 ft. £10 17*s.* 6*d.* These estimates were fully confirmed, and the consequent saving had been more than Sir Charles had stated.

Joseph Cubitt read a paper containing a description of the Newark Dyke bridge, to carry the Great Northern Railway across the Newark Dyke, a navigable branch of the Trent, at Newark, at the last meeting of the Institute in 1856, and its interest was greatly increased by the circumstance that Sir Charles Fox invited the members to see it erected at Fox and Henderson's Birmingham works before being taken to its destination, and drew out all the statistics of the deflections obtained by the test in three or four elaborate tables, which are entered in the Proceedings. In the subsequent discussion he referred to the advantage of building in this form, because the service of skilled workmen in the actual erection had been obviated by its being put together, tested, and marked at the factory, and thereby ordinary labour could place it on the piers.

In the old and forgotten controversy as to the use and relative advantages of the bridge-shaped, T shape, and double T shape for rails, Sir Charles gave the preference most decidedly in favour of the latter, and instanced by experiments the truth of his conclusions by referring to the Brighton and Chichester line.

Again, in another field, wherein much of theory existed, and had to be eliminated by practice, the question of material for submerged telegraph cables in deep seas had a prominent position. He took up the defence of that which has proved to be the only cable to be relied on, and objected to the use of steel as covering, saying, "The use of copper, not iron wire, was essential, and the mode of insulating (Chatterton's patent) as good as could be." He thought the present knowledge of deep-sea currents inadequate, but cables covered with longitudinal fibres of hemp, which was double the strength of iron, with a close serving of hard yarn well soaked in pitch and tar, were apparently the only cables that could be trusted, and if no deep-sea currents existed the greater part of the difficulty had vanished. We have found since then that there are no deep-sea currents of any account, and the hemp-covered copper cable insulated with gutta-percha is the only available one for such seas as the Atlantic.

The question of the best method of constructing artillery had its ventilation in 1859-60, and a very elaborate paper was read by Mr. J. A. Longridge, defining the limits within which the civil engineer could work without intrenching upon the ground of the military engineer; and in the subsequent discussion Sir Charles Fox enumerated some principles which show him to have been imbued with the advanced thoughts and hopes of the metallic world, and it is important to observe that what he desired and could not see possible has, through Mr. Bessemer, been proven to be not only possible but realizable.

Sir Charles Fox said, "Some years ago I expressed the opinion that it was important to arrive at that condition of things in a gun which, when an explosion occurred, should make the whole thickness of the gun available. At one time I thought I had discovered it, but now I see great difficulties in reaching that result. If a gun," said he, "were built in separate parts without a soldering cement or welding, I think it would very soon be of no use. Guns can be made by using an inner tube and turning the outside to a correct cone, and by hydraulics pressing thereon layers of hollow cylinders to protect strain, but I think if you use that gun in so changed a condition you destroy all you gain

by your expensive construction. You cannot make guns by a wire encircling, especially in the breech, but in the end you will find that the best gun can be constructed without the hammer."

In an argument on railway viaducts, Sir Charles Fox begged to state a case in his own experience. "In 1851, a bridge on caissons was built at Lyons for the Paris and Lyons Railway. It fell down because the sand of the foundations was washed away in consequence of the fouling of an iron-laded barge. It was a 4-arched bridge, and every arch had a 100 ft. span. They wanted to open the bridge as early as possible, and therefore desired a wrought-iron bridge instead of rebuilding the old in masonry."

He accepted those conditions and went to work. The pier consisted of three cast-iron cylinders of 10 ft. each diameter, sunk into the Saone 50 ft. deep. The platform held the permanent way on four girders resting on the abutment with level tops, and standing on a pier in the middle of the bridge level with the platform. Those girders, of 215 ft. length and 15 ft. deep, weighing 108 tons, were put in place without scaffolding. They were built at an angle which allowed them to roll down to the proper level so as to come on the top of the pier as it crossed the water. "In the first place," says Sir Charles, "all the four girders on each abutment were moored halfway over the span and left as cantilevers, with ends held down by bolts into the land arches below which could carry the load. Under these ends were firmly fixed two baulks of timber to carry a roller in succession under the girders, and then by gravitation each would move over the span to the pier. The head in, the tail was rolled to the level required, but no scaffolding was wanted."

At the discussion upon the new railways at Battersea and Victoria, Pimlico, Sir Charles Fox, the engineer of those works, contended for the employment of cast iron in preference to wrought in the construction of arches, because it was not only cheaper but more durable. He thought engineers had gone astray in the use of wrought iron in various structures, because he was sure that cast iron, properly prepared and proved, was perfectly safe. In the girders for the Exhibition-building he incurred much opposition; but they did not fail, because every girder was put into a hydraulic press and proved the moment before it was required, and some of them broke in the test and were not employed. He saw no difficulty in making bridges of 200 ft. span of cast iron, and referred to Southwark Bridge as a monument to Rennie, and one of the finest structures of the day. However, he would use wrought iron for longitudinal girders, because the alterations of temperature did not have the destructive effects they had on cast-iron. The limit of elasticity must be considered, and there could be no doubt that the use of wrought iron for longitudinal girders was beneficial. Those who knew of railroad construction were aware that platelayers put a penny-piece between the ends when working in winter to allow of the expansion in summer.

Many years ago it was considered, in proving an iron structure, that if it took a permanent set it was damaged, but he had reached the conclusion that all structures on first loading did take a permanent set. Some years ago he took a contract for suspension-bridge chains, and the specification said that any link that took a permanent set would be rejected. He made a proving-press, and found that the first time any bar was stretched it took a permanent set. An engineer once said to him, "If your structures take a permanent set, I will reject them." His reply was, "Then you will reject them all, for they all do that."

He then discussed the structure of piers, and contended that the cheapest form was that by cast-iron cylinders: explained the difficulties he had met in executing the transit of the Thames, and in defending his entire work showed that the cost of the whole, £920,000, was but 1¼ per cent. in excess of the estimates. He built also the Barnes and Richmond bridges.

A very interesting debate on the strength of iron and steel brought out Sir Charles Fox's practical knowledge of the subject, and also the expression of Mr. Vignolé, the President's, approval. The detail would be too long for notice here.

Then in an animated discussion in 1868 on the supporting power of piles and the sinking of iron columns Sir Charles Fox took a most prominent part, and showed that the so-called modern methods had been employed by himself and his friend Mr. Brunel for more than twenty years, especially with regard to iron cylinders, in which he was supported by the testimony of Mr. Brereton. Upon another occasion he vigorously took up the argument as to the relative value of the pneumatic and atmospheric systems for railways, preferring the former, and giving his reasons against the latter. Then again a very influential assembly discussed the question of gauges in foreign railways tributary to main lines, and he gave his preferences and reasons with singular lucidity, based, as they were, upon his personal experiences in foreign lines in Canada and in India. The result of his knowledge on such subjects can be gleaned in another debate upon American locomotives and rolling stock, in which he took a prominent part on the question of loading, and the construction of wheels and axle-boxes.

Sir Charles Fox had also the honour of a seat at the Council of the Institution of Mechanical Engineers, and attended their meetings and took part in the discussions.

His last great building contract may be said to have been the transfer of the Palace in Hyde Park to the Norwood hills. The commissioners had found immense trouble in disposing of the structure, as the public insisted on its removal from the public park, it having accomplished its purpose. At length the Crystal Palace Company came into existence for the purpose of securing the materials and removing them to a new site, and for permanent purposes. The architects throughout the country, and Mr. Ruskin, the critic, exclaimed at the idea on the ground of its unfitness and the great engineering difficulties of a suitable foundation. Fox accepted the contract, and the fairy-like building soon flew to its present rest. "As erected at Sydenham," says Mr. Fergusson, "the building has far greater claims to rank among the important architectural objects of the world. In the first place, its dimensions are unsurpassed by those of any hall ever erected. Its internal area is four times that of St. Peter's at Rome, and ten times that of our St. Paul's. A second merit is, that its construction is absolutely truthful throughout. Nothing is concealed and nothing added for effect. A third is, that it is ornamentally arranged. Nothing can well be better, or better subordinated, than the two great minor transepts joined together by the circular roofs of the naves, and the whole arrangement is such as to produce the most pleasing effects both internally and externally."

In preparing the foundations for the columns, great care had been taken to arrive at the gravel, upon which a bed of concrete was thrown, providing for a pressure of 2¾ tons per superficial foot. This concrete, of 3 ft. to 4 ft. in depth, was finished by a covering of fine mortar worked even and with a level face. On this was laid a base plate for each column, the lower part consisting of a horizontal plate having attached to it a vertical tube of the form of the column it was to carry, which columns were the water conveyance to a set of drains from the roof to the tanks provided. At the upper portion of the base-plate four holes were cast in projections; these answered to others at the foot of the columns, and both were secured by nuts. Between shaft and base, pieces of canvas dipped in white lead were introduced to make all watertight. The whole structure was erected in an incredibly short time because the same cubical measure of the parts was adopted as had been selected in Hyde Park.

The opening ceremony took place in May, 1854, under circumstances of great splendour. Her Majesty attended, with the Prince Consort and the Court attendants, and the most flattering and auspicious surroundings served to remind the spectator of the Great Display in 1851, which of course it could not excel, or indeed imitate.

It was just such a wide and varied knowledge and experience that qualified young Charles Fox to forsake the surgery and devote himself to mechanical science; and it was the culture of those general and comprehensive elementary acquirements that made his range of subjects almost boundless, and enabled him to be of such service to his generation. In him science lost a brave and devoted son.

His remains were deposited in Nunhead Cemetery in the year 1874. W. S. C.

PURIFICATION OF EASILY FUSED METALS BY MEANS OF FILTRATION.

BY filtration liquids are freed from foreign undissolved substances in suspension. The particles of these substances remain on the filter, and the liquid contains none but those which are in solution. This object is attained when the pores of the filter are smaller than the foreign solid particles, but not unless the filtered substance exercises some force of attraction on the liquid particles, that is to say, is moistened by them. Otherwise the pores do not act as capillary tubes, and there is no filtration. Hence even mercury can be supported by a wire gauze which is far from fine. The same holds good of copper trellis, but if this is amalgamated, the mercury passes through immediately, and if in this mercury there are small frag-

ments of iron, copper, and amalgamated metals, they remain on the trellis.

Prof. Lampadius, of Freiburg, who enjoyed a high reputation as professor of metallurgy, made experiments in the filtration of easily fused metals under the guidance of this principle, that in the case of metals which soil they are suspended at a certain lower temperature in the principal mass which is in a state of fusion, and consequently can be separated by filtration. Although in his experiments he employed quartzose sand, powdered cinders, and other similar substances which consequently were not moistened by the metal on which he experimented, the results were nevertheless satisfactory, for the crystalline compounds which had been formed were separated. But the fluid metal which had passed through was very impure, because the spaces of the filtering medium were too large, and consequently had not the property of attraction belonging to capillary tubes. The experiments were made with various alloys of tin, lead, bismuth, antimony, and zinc, mixed together.

The problem was to find a filter which—as filters of paper, linen, &c., can be moistened by water and solutions, and can consequently be employed for their filtration—might possess the property of being moistened by the metals to be filtered, without at the same time being dissolved, and without rendering them impure. Prof. Lampadius had formerly investigated the possibility of purifying by filtration the native tin of Bohemia, which is far inferior in value to the English tin and that of the East Indies, since, on account of the foreign substances it contains, it cannot be used for painting, enamelling, and the manufacture of glass and pearls.

It is well known that purification can be effected by means of acids and other chemical agents, dissolution, precipitation, &c., but this method is too costly. Hence another had to be sought. Iron does not fuse at the temperature of the fusion of tin, though it has a great affinity for it. On this principle depends the tinning of iron. Consequently iron appeared suitable to serve as a filtering medium. In plates of sheet iron tinned of the thickness of paper, strips were cut 6 in. long and 4 in. broad. Five hundred of these strips were firmly pressed side by side to each other in a rectangular iron frame by means of two wedges. This frame was cemented in a corresponding opening made at the bottom of a graphite crucible containing about 400 lbs. The tin to be purified was melted in a second crucible, then left to cool, until on the surface small crystals were seen to separate. Hence the foreign substances in solution were separated, and then the metallic mass which had become rather thick was put into the filtering crucible.

After the liquefaction of the tin found on the small plates of sheet iron, the filtration of the remaining pure part of the metallic mass began. There remained on the filter a pasty magma or sticky substance, in which iron, arsenic, and copper, concentrated to a high degree, were chemically combined with the tin, while the tin which had passed through the filter appeared, when chemically tested, to be almost chemically pure, and, after being treated with nitric acid or according to the dry method, gave an oxide of tin almost without colour.

This first experiment was so satisfactory that more than 50 cwt. of impure Bohemian tin was purified with this experimental filter. The purified ingots were sent with the apparatus to the Universal Industrial Exhibition at Vienna in 1845, where, however, they were unobserved. As the purification of metals is often greatly to be desired, a process which has been proved to be practically serviceable for the purpose ought to be rescued from oblivion, and for that reason attention is here directed to it. *Wochenschrift der N. O. Gewerbe-Vereines.*

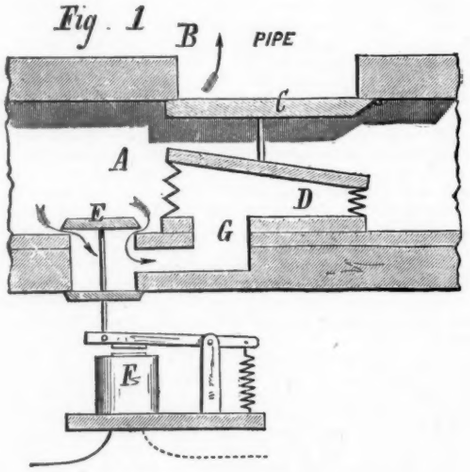
NEW APPLICATIONS OF ELECTRICITY TO ORGAN BUILDING.

A CONCERT organ has recently been erected in Chickering Hall, corner of Eighteenth Street and Fifth Avenue, in New York, which is remarkable for the numerous entirely novel and ingenious electrical and pneumatic inventions which enter into its construction. The instrument is one of considerable magnitude, having three manuals, a compass of 58 notes, 29 pedal notes, 33 stops, and the necessary couplers and mechanical accessories. So far as the location of its parts is concerned, it is really three organs in one; that is to say, a portion of the pipes is on one side of the stage, a portion some 60 ft. away on the other side, while a complete though small organ, used for echo effects, is placed on the roof of the hall and about 175 ft. distant from the single set of keyboards at which the entire apparatus is manipulated.

The portion of the instrument which is directly in rear of the keyboards is provided with pneumatic levers, so that the pressure on a key, instead of acting directly upon the valve of the pipe to be sounded, opens a valve which admits air into a small bellows. The latter, in its movements, actuates the pipe valve, and thus performs the heavy work, so that the merest touch is sufficient to move the key. With the exception of this ingenious pneumatic device, all the rest is directly mechanical, and, since it does not differ from the usual church organ arrangements, needs no further reference. In the other two organs, however, are found the curious electro-pneumatic inventions which have seemingly revolutionized the art of organ building, for by their aid not only can new effects be produced, but one or a dozen organs can be played at once, and all their stops perfectly controlled, and this irrespective of whether they are located within ten feet or ten miles, or, in fact, any distance, from the player.

We propose to explain, by the aid of the annexed diagrams, first, how the pipes are sounded through pressing the keys, and, second, how the stops are manipulated. For the benefit of those unfamiliar with organs, it may be stated in advance that,

Fig. 1



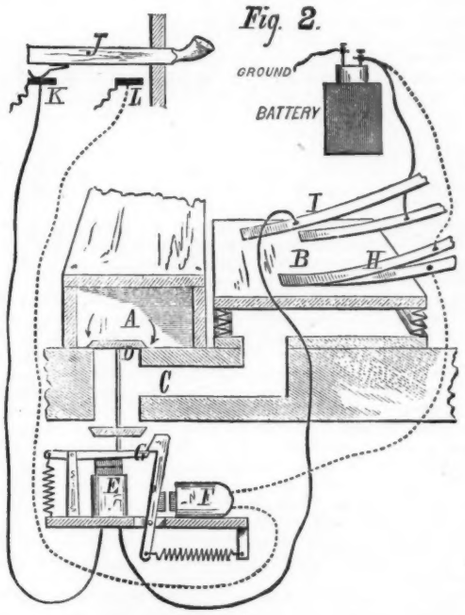
by means of stops, air is admitted from the main bellows into any desired set or sets of pipes. Each set of pipes gives a different quality of tone, and thus the performer may select just such sounds (flute-like, trumpet-like, &c.) as best suit the character of the music. Having regulated his instrument by adjusting the stops, his fingers, by pressing the proper keys, open the valves leading to the individual pipes, and thus the instrument is played. In order to apply electricity to the object first mentioned above, it will be obvious that the keys must act exactly as do the keys of an ordinary telegraph instrument, that is, on being pressed down, they must establish a current which, passing over a connecting wire, actuates mechanism at a distance. This is precisely the case, so that the organist has no power to exert beyond the very light pressure necessary to so move the keys. Each key controls its own circuit; and as the mechanism is the same for each, a description of one will suffice for all:—

In the diagram, Fig. 1, A is a part of the air chamber, in which air, led by an air trunk from the air bellows, is kept compressed. B is the pipe corresponding to the key whose operation we are considering. There is an opening between the air chamber and pipe, closed as shown by the valve, C. Attached to this valve is a small bellows, D. Through the bottom of the air chamber is another orifice in which plays the double valve, E, the stem of which is continued downward and is attached to the pivoted armature of the electro-magnet, F. Said armature is provided with a spiral spring, the effect of which is to hold it away from the magnet and so to shut the lower part of valve, E, while holding the upper part open. This being the case, a portion of the compressed air in A will pass under the valve, but, being unable to escape at the orifice below, will enter the channel, G, and so ascend into the bellows, D. There will therefore be a constant equilibrium of pressure

about the bellows, and thus the valve C will be pressed tightly shut against its seat.

When, however, the key is pressed, then the circuit is established, and the magnet, F, becoming excited, draws down its armature, thus shutting the upper part of valve E, and closing the lower part. The air in the bellows, then being free to escape through the passage G, cannot equilibrate the pressure in the air chamber, and hence the bellows closes, and at the same time pulls down and opens the valve C. A blast of air is then free to enter and so sound the pipe. This state of affairs holds as long as the key is held down; but the instant it is released, the circuit is broken, and the various parts regain their normal position. The apparatus is extremely sensitive, and in its prompt action even surpasses the damper movement of a fine pianoforte; so that, in fact, the quickest passages and shortest notes can be played with a clearness, crispness, and brilliancy hardly otherwise attainable. Of course the intervening distance between this mechanism and the keyboard is practically immaterial so long as there is sufficient battery power. In the echo

Fig. 2.



organ, previously referred to as located in the roof of the building, six Leclanché cells are found amply sufficient, although there are some two miles of connecting wires. This very light battery power required, in fact, is characteristic of the whole instrument.

Having seen how each key is worked, we now pass to the means whereby the whole set of 58 keys is caused to control any desired set of pipes. In Fig. 2, A is an air chamber or wind box, fed as before from the main bellows. The small bellows, B, in this case is located outside of the chamber, but communicates with it by the passage C, in which is a double valve, D, similar to valve E, in the preceding diagram. When the upper part of valve D is raised and its lower part closed, there is a free passage for the air to pass from the wind box and into the bellows. When the valve is lowered, as represented, there is a clear passage from the bellows to the outside air. The stem of valve D is connected with an electro-magnet, E, arranged as previously described. There is, besides, another magnet at F, which controls a moving armature, G, one end of which forms a latch and engages with the armature of magnet E. On the top of the bellows are two pairs of springs, one pair, H, being in control only when the bellows is down, the other, I, being in like condition only when the bellows is inflated. J is the stop in the organ, on the lower side of which is a switch which comes in contact with one or other of the metal plates, K and L, according as the stop is pushed in or drawn out. The lead of the circuits is first from plate K to magnet E, thence to the upper spring of pair I; from the lower spring of same pair to the battery. The second circuit passes from plate L to magnet F, to lower spring of pair H; from the upper spring of same pair to battery. The object is to move the bellows, and this last moves a series of switches oscillating on a horizontal axis so as to establish connection in 58 key circuits at once. When the stop is pushed in as shown, there is obviously no connection with the battery, because of the pair of springs, I, being separated. Supposing, however, the stop to be drawn out, then the switch on its lower side comes in contact with plate, L, the current passes and excites the magnet, F, which draws back its armature, G, and so releases the armature of magnet E, the current of course continuing through the pair of springs H, and so to battery. But the effect of releasing the armature of magnet E is to raise the valve D, so that, as before stated, the air from the wind box is allowed to pass through the passage and into the bellows. The latter then rises, throwing over the 58 switches and so establishing the connection of the keys. But as this rising continues, the springs H separate; the circuit is thus broken. At the same time the pair of springs I come in contact. The bellows remains, however, inflated, because the position of valve D remains unchanged, no circuit being complete through the springs I and magnet E, until the stop pushed in establishes connection with plate K. Consequently, the bellows will stand full and thus push the switches into action as long as the stop beside the keyboard is drawn out. When that stop is pushed in the circuit closes, magnet E is excited, and valve D drawn down, cutting off any further supply of air to the bellows, and opening an escape for its contents. As valve D falls, the catch on armature G slips over the armature of magnet E; and, as the bellows descends, springs I once more separate, and thus the parts are again brought to the condition shown in the diagram.

It will be observed that this is all done with an open circuit; that the circuit, in fact, is always open, except just when changes are taking place, so that, with a battery like the Leclanché, which stands out of operation when there is no circuit, the exhaustion of the same is very slow and the cost consequently light.

There are various other ingenious attachments of less importance than the foregoing, which are hardly necessary to be described. The credit of the inventions belongs to the builder of the organ, Mr. Hilborne L. Roosevelt.—*Scientific American.*

IMPROVEMENT IN PROCESS OF MELTING IRON IN CUPOLAS.[1]

AT the Edgar Thompson steel works (Bessemer), at Pittsburgh, the difficulty which frequently occurs in the cupola for melting iron in continuous use, of a scaffold (or obstruction of metal and coke in form of a mass or shelf adhering to the sides of the cupola) presented itself; and the superintendent of the works, Mr. Wm. Jones, conceived the idea of effecting the removal by the use of pulverized fuel, injected with the blast, at the tuyeres through which the air was usually forced. Upon placing a quantity of small coal in the tuyere pipes, and putting on the blast, the result was immediately successful in the removal of the entire scaffold, and the cupola afterwards continued in work as usual. A further consideration led to the conclusion that scaffolding might be altogether prevented by a continuance of the process, and an arrangement has now been effected, whereby a portion of fine coal is infused into the blast at all times; which process has not only prevented the formation of scaffolds since, but has melted the iron so much better and more rapidly that only one cupola is used at this time, where two were necessary before the pulverized fuel was introduced.

But this is not the only or most important advantage secured by this discovery. It is well known to the iron founder that the great waste of iron in melting in a cupola occurs from the exposure of a mass of white-hot or melted iron, where little or no fuel is present, to a current of air in which the iron itself burns freely. By supplying a portion of carbon with this air, not only the requisite heat for melting the iron will be furnished, but the iron itself will be protected from oxidation. The tuyeres of the cupola at the Edgar Thompson steel works, when using the pulverized fuel, are as bright as those of a blast furnace at a temperature of 1000° Fah., and the walls of the lining are glazed.

This improvement is found not only to save the waste of iron, but to transmit to the converter a much larger proportion of the

[1] Extracted from *Am. Manufacturer and Iron World*, Pittsburgh, Feb. 24, 1876.

carbon originally in the pig—a very important consideration. In conclusion, this improvement is not limited to the Bessemer process, but would be of great value to all cupolas melting iron for castings of any character, as well for the light castings of the stove moulder, where it would preserve the fluidity of the metal and softness of the plates, as also for the machinery founder, where the uniformity of character from long or heavy heats is especially desirable; and it is possible that the principle may be extended to the blast furnace itself.

IMPROVED CONSTRUCTION OF MILLSTONES.

IN the manufacture of large millstones the object sought is first to convert the grain into groats or coarse meal, and afterwards obtain fine white meal or flour from the groats by further grinding; but the highest possible percentage of groats can be obtained only by a more or less complicated combination and repetition of partial grinding, with a subsequent sorting by hand. The direct production of no inconsiderable

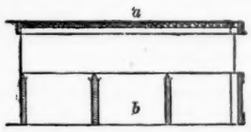


Fig. 1.

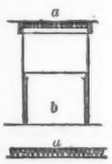


Fig. 2.

quantity of flour, with the undesirable crumbling of part of the husks, is unavoidable, as all the products of the grinding necessarily do not leave the stone till they get to the circumference.

The improved millstone of Messrs. Israel Brothers is intended to remove the products out of the reach of the grinding surfaces as soon as the grain has been crushed to groats. For this purpose sieve-plates, with holes of suitable size, are placed in the

Fig. 3.

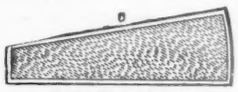


Fig. 4.

lower stone, exactly or nearly on a level with the grinding surfaces, to let the groats and small pieces of husk fall through. They will consequently no longer be moved round between the grinding surfaces and further crumbled. There is a sorting of the finished and unfinished meal, and hence the lower stone is called the sorting millstone.

The construction of the stone is exhibited in our illustrations.

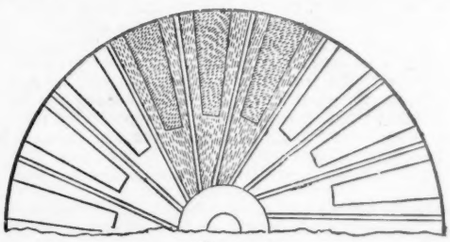


Fig. 5.

The sieve-plates *a a* are here supposed to be made of cast iron, and pierced with holes widened below. They can, however, be made of wrought iron or other metal, or even of wire. Beneath these plates the stone must be open to let the coarse meal fall through, and hence it is necessary to insert in these openings of the stone iron frames, *b b*, with cross ribs, or some other apparatus, to maintain the connection of the several parts of the stone. Between the sieve-plate *a* and the frame *b* a projection is left in the stone, to allow of placing the frame lower in case of need. The roughness of the stones, as well as the form of the sieve-plates, can be varied as may be desired.

The special advantages to be obtained by this construction are the following:—

1. The production of a larger quantity of groats. Even if a certain quantity of coarse meal is mixed up, it is comparatively small, and experiments have shown a gain of ten to fifteen per cent. in the resulting quantity of flour compared with preceding processes.

2. The inserted sieve-plates favour ventilation, and the removal of a quantity of the meal at the circumference of the stone diminishes the friction, in consequence of which the grinding produces less heat and better flour.

3. In consequence of the removal of the coarse meal at the circumference of the stone, and since the breadth of the grinding surfaces between the sieves is only about half as great as with common stones, the resistance between the upper and the lower stone is lessened, and hence there is a saving of thirty to forty per cent. in moving power, as experiments have proved. *Bayerisches Industrie-und Gewerbe-Blatt.*

APPARATUS FOR GIVING WARNING OF EXPLOSIVE OR DELETERIOUS GASES.

MR. ANSELL has devised an apparatus for indicating the presence of the smallest quantity of explosive or deleterious gas in any mass of air however large.

It is known that when two gases are separated by a membrane or porous partition, they tend to mix by endosmose, but the velocity with which the movement takes place is different for different gases, and is found to be inversely as the square roots of their densities. It follows from this law that if two gases of different densities are separated by a porous partition, they mix by passing through the partition, but the less dense gas will penetrate into the space occupied by the denser far more abundantly than this latter will escape. There will consequently be an increase of pressure in the space it occupies.

A first indicator is composed of a metallic barometer, enclosed in a brass box, the bottom of which consists of a porous earthen material. If the box is placed in an atmosphere containing proto-carbonate of hydrogen, or any other gas less dense than air, this gas will filter through the porous partition into the box, and the quantity which enters will be greater than that of the air which escapes. Hence there will be an increase of pressure in the box, and the barometer will come under the influence of that pressure.

If the barometer is placed in an atmosphere containing carbonic acid gas, or any other gas denser than air, it will be affected in a contrary way. The air in the box and the carbonic acid gas will mix by filtering through the porous partition, but the quantity of air that goes out of the box will be greater than that of the carbonic acid gas that goes in. Consequently there will be a diminution of pressure, which will tell upon the barometer.

Hence it is evident that such an apparatus placed in the gallery of a mine might warn the miners of the presence of proto-carbonate of hydrogen, but they must observe the barometer to become aware of danger. This is a serious drawback, which Mr. Ansell endeavoured to remedy by a further contrivance. It consists of a small tube bent into the form of a U, one of the branches of which ends in a funnel closed by porous earthenware. The tube contains mercury, and in ordinary circumstances, when the apparatus full of air is placed in pure air, the surfaces of mercury in the two branches are on the same level. But this is not the case when the air is vitiated by proto-carbonate of hydrogen. This gas will filter through the earthen partition, penetrate into the funnel, increase the pressure, and make the column of mercury rise in one branch of the bent tube so as to cause a contact between two platinum wires which terminate in the two poles of an electric battery. The current is thus established, and if an electric bell is placed in the circuit, a signal will be given, which can be conveyed to any distance. The apparatus being placed in the gallery of a mine, and put in communication with an electric battery, as soon as the combustible gas escapes from the subterranean cavities, it makes the bell sound, which may be placed out of the mine in the engineer's office.

Though not yet extensively used, this apparatus has been attended with favourable results in several coal mines. *Revista Scientifico-Industriale, March*, 1876.

AIR COMPRESSION.

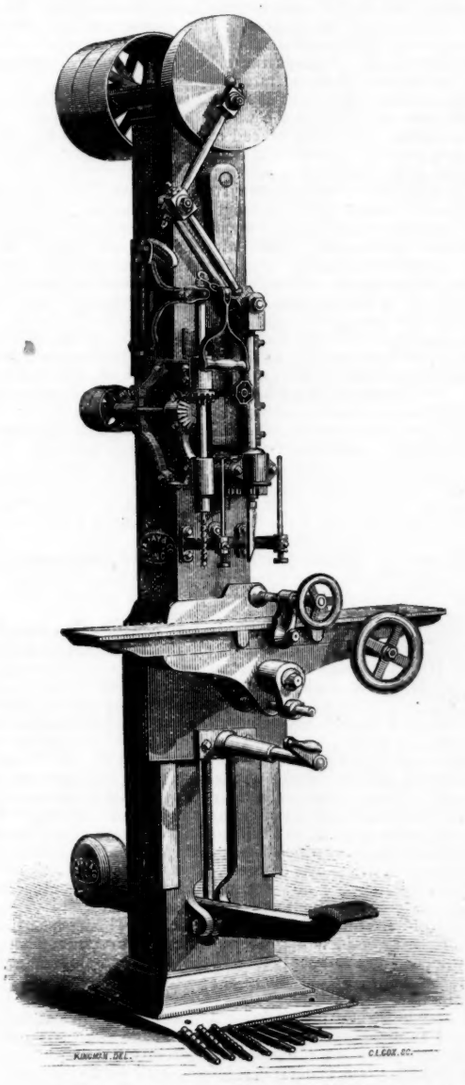
AT a meeting of the Society of Engineers held on Monday evening, the 3rd of April, in the Society's Hall, 6, Westminster Chambers, Mr. V. Pendred, president, in the chair, a paper by Mr. J. Steel on "Air Compression," was read. The author, in commencing, observed that although Hero of Alexandria had experimented on air compression, and had written a book on pneumatics, the subject did not assume practical importance until after the discovery of the ponderosity of the atmosphere by Galileo and Torricelli in the middle of the 17th century. Savery and Papin, two of the early inventors of the steam-engine, appeared in modern times as first on record in connection with air compression. Savery used a double-acting bellows to give a constant stream of air for blast furnaces. Papin, whose ideas are particularly practicable, recommends the utilization of water-power to compress air, and force it to a distance for use. Papin may thus be said to have foreshadowed the now common practice of distributing air through mines to work machinery. In 1757 Isaac Wilkinson patented a method of compressing air by the use of a column of water. He effected his object by means of a series of vessels used one after the other, so as to keep up a regular pressure. This is an important proposition, and 100 years before its application indicates the method of procuring air employed by the engineers of the Mont Cenis Tunnel. In 1829 William Mann patented stage pumping; that is, a process by which, instead of raising the pressure at once, and in one pump, it is divided into several pumps, an increment of pressure being taken from each. That method, spread as it is over more time and surface, allows a considerable cooling of the air to take place, and a lowering of the initial heat of the air supplied to each pump, and so far reduces the waste of power in compression. It likewise reduces or distributes the mechanical strain, allows the use of lighter machinery, and reduces to a minimum the fly-wheel power required. The author then described Sturgeon's high speed air compressor, and afterwards a small one designed by himself for compressing air for his patent railway brake. He showed that in an engine with one pump only of 30 in. in diameter, and working up to 500 lbs. on the square inch, the pressure on the cylinder covers, and the load on the cranks at the point of turning the centre would amount to 150 tons, while, if distributed over four pumps, that load would be only 10 tons on each pump. That was the point to which the author attached most importance. He exhibited diagrams showing the effects of heat and expansion, and showed that even at the comparatively low amount of compression of two atmospheres, the heat doubled the volume, and if no means were taken to reduce the heat as it was formed, a loss of half the power employed in pumping ensued. Formulæ, for ascertaining the relations of compression and heat, and examples of the same were also given. The author pointed out the necessity of placing air compression on a proper basis, as, whether an economical mode of using power or not, in mines, chemical works, diving bells, raising ships, and other operations, it had become a necessity. It was also to be regarded as an alternative from the cost and waste of horse-flesh to propel tramway cars.

MORTISING AND PIERCING MACHINE.

THE apparatus represented in our illustration is one of those remarkable inventions in woodwork which are now appearing. A few years back, such a machine as we represent to the reader would have been regarded as a marvel of mechanism, and many persons would have doubted the possibility of constructing a machine capable of piercing holes with different augers, and cutting mortises with chisels acted upon by an up and down movement. But the improvements in machines for working wood have been rapid and varied, and on the whole they have been more remarkable and numerous in the United States than in this country. Their importance and utility have been widely recognized, both in reference to the saving of hand-labour and the rapidity and perfection of the work, which are far superior to what can be obtained from manual labour.

Unlike other machine makers, those engaged in making machines for working wood confine themselves entirely within their special department. They combine in this class of apparatus the best systems, the best materials, and employ the most skilful workmen. The most ingenious and rapid movements have been introduced and employed by them in tool-machines intended to execute special kinds of work on wood. Between the simple screw for wood with auger point, and the most complicated machines for engraving wood, there is a numerous and interesting series of useful improvements and practical inventions, derived from American inventors and makers of wood-working machines.

A simple inspection of Messrs. Fay and Co.'s mortising and piercing machine is sufficient to show its practical utility, and



MORTISING AND PIERCING MACHINE.

the remarkably ingenious way in which it has been contrived. Among the various systems in use for mortising wood, that of a chisel with alternate vertical movement has been preferred, and in machines of this kind one or two different systems may be adopted. Either the table is adjusted vertically to receive the thrust of the tool which has to pass over a fixed distance without any change in its points, or the table can be fixed and the chisel lowered from its highest position to the depth of the mortise and over the whole length of the range. The machine we represent is an excellent example of this latter system. It is a mortising machine with variable range, suitable for every kind of work.

The support is a cast-iron column with broad section and solid base. The motor beam, bearing pulleys and wheel with crank,

is placed at the top of the column, and turns in self-greasing axle-beds, with cap-pieces firmly fastened by bolts to resist the strain they undergo from the action of the tool.

The pedal is attached by a rod to a short crank placed at the hinder extremity of the beam, to which the radial arm is fastened in front. This arm is united with the central joint of the rods which connect the tool-holder with the button of the crank of the wheel.

When the pedal is lowered, the radial arm is displaced, and the central joint brought near the vertical line passing through the centre of the motor beam, thus producing the complete range of the chisel with all the changes from the position of rest. To the short crank placed on the shaft of the radial arm is fastened a friction-slide, which receives the force of the range of the chisel, and thus entirely destroys the effects which that force might exert on the foot of the operator.

The piercing apparatus is placed in the central line of the chisel, and can pierce to the whole depth of the mortise. It is set in motion by a pulley placed on the beam at the top of the column, and has a fixed and a loose pulley, so that it can be stopped while the chisel is working.

The table is on a compound system. The wood can be moved about on it according to the length of the mortise, or the table itself can be moved, with the wood fastened on it, by means of a rack and pinion and a hand-wheel, which are seen in front. The mortises may be of various dimensions, and special arrangements are contrived for this purpose. The table can be adjusted at any angle whatever, and for any mortise whatever, as easily as for a right angle.

An important feature of this machine is the truly automatic reversal of the movement of the chisel, which takes place at the same time that the chisel is raised and separated from the mortise. This being accomplished when the mortising is completed, the chisel is thus put in position for the finishing.

The European agent for Messrs. Fay and Co. is M. Wilczyrski, of Hamburgh. *Moniteur Industriel Belge, Feb.* 20, 1876.

PERSIAN OBJECTS IN THE SOUTH KENSINGTON MUSEUM.

THE appetite for universal conquest has ended in the annihilation of all the Oriental monarchies, and left us in possession of little more than fragmentary knowledge of their manners, customs, and religions. The reflection that the man-destroying instinct has extinguished so much invaluable lore is a very melancholy one. It would seem as if a Nemesis followed the successes of war, and obliterated all that could remain of such unworthy specimens of our race. These fragments convey such a lesson; and whilst the collection and examination of them afford ample sources of interest to our present generation, we must not forget that in these ancient relics we may trace the tardiness of the decay which finally extinguished their power and influence even in the arts of peace.

The Exhibition we now notice has been on view only a fortnight, and is therefore not as yet familiar to visitors in general. It has an interest at once unique and inclusive, being exclusively Persian, and yet including every variety of arts, manufacture, and industry that can set before us the taste and skill of a lost time.

As in all Oriental displays the result is a combination of brilliant and even startling colours and eccentric devices, rather than of essentially beautiful forms, although the elements of beauty and grace are not wanting: for instance, in the metal-work division; and, generally, throughout all the divisions in the articles marked Old Persian, because the date of production is lost in the distance of ages. The lamp of tinned copper, circular, with handle and lid for suspension, has enchased a design of flowers and animals in open work, and engraved with inscriptions (424-'76); the bowl and plate of tinned copper, engraved with females playing musical instruments, birds, and flowers, with inscriptions filled in with black (430, 1-'76), and its neighbour, of the same bronze-looking metal, chased with groups of flowers and inscriptions; the double-socketed candlesticks of chased brass; the fine Hookah-bases of brass and tinned copper, all deftly engraved with great pains and labour (436, 7, 8-'76); the specimens of carved pear-wood; and the coffers of solid silver: these at once strike the imagination as works of a pure and delicate art. And here it is well to note that throughout the ancient specimens, whether of wall tiles, metal work, or carving, the universality of inscriptions—a man's dwelling in those far-off days, when, although of "the making of books there was no end," there was no printing press—every article of use and every attempt at decoration contained *thought*—generally specimens of poetry appropriately selected from their few but gifted writers, or graceful proverbs for which the ancient land was famous. Herein this collection will most certainly effect a revolution in our senseless waste of opportunity. We carefully select articles, colours, forms, and material, according to taste, intending that all shall express the mind of the owner; but how much more vividly would that object be realized did we clothe every substance with an expressed idea, wish, or thought. The dining-room cornice, the panelled wall, the skirting could be made to convey exquisite delight by having an intellectual decoration, rather than the symbolic vacuity of dazzling paper hangings, everlastingly repeating themselves, and saying nothing; and the massive gilded cornice, tawdry and meaningless, except to say that the owner possesses gold; hospitable proverbs, didactic remembrances of the poor, or grateful allusions to the necessity and pleasures of eating and drinking, must quicken and elevate the conversation, and enhance the pleasure of all, host and guest. So of the billiard-room, the drawing-room, and the library. In the old days of Persia—now, alas, faded all away under a cursed sensualism of body, and a senseless mode of worship—there must have been much private domestic joy. The worship of the sun was not a bad idea, although it could not prevail; but it was better than the seraglio, and the hope of seven paradises of women at the end to which it has given place. Their purity must have been singular among the nations. We find no nude figure; indeed, it would seem that the wondrous ideal beauty of the human form had never struck upon their imagination. They loved wine and they loved women; but it was that generous domestic love and hospitality which sought its enjoyment in its own friends and connections.

Even under the present, and most likely permanent degradation of Persia, this domestic character is seen in the selection of the existing manufactures. A country that abounds with vegetation, notwithstanding its large inconvertible deserts; a country that feeds its own population, and exports very choice natural products, and could therefore become manufacturer of many other staples—we see a clinging to their carpets of exquisite design and elaboration, and ladies' and children's dresses of comprehensive unity in pattern, bells in imitation of plants, with six or seven internal plates, writing-cases of copper with black enamel ornament, candlesticks of engraved brass, the hollows of which are filled up by tinted varnish, choice samples of Eastern marquetry, &c.; these show that while the genius of Persian art had died out, there remained a power of adaptation which could, like the old nation did to the people it conquered or was conquered by—take up the example of China, India, and even the unsurpassable native of Japan—and from these evolve trade and manufacture sufficient to manifest its capacity, and supply its necessities. Not only do we trace the Eastern in the forms employed, but we trace the adaptation of these to the change of religion which came of the conquest by Mahomet, and the absorption of even that into the relics of their ancient worship. Particularly, there is the prevalence of the blue turquoise among the various colours, and the depth and intensity of the glaze and metallic lustre, where blue in every shade is employed. Their ancient potters endeavoured to reflect, or rather emulate "the hues of heaven." Sèvres has not the like thereof, and chemists cannot reproduce it in that bygone glory. Some of the choice specimens have been sent to Burslem on loan for exhibition. There is a dark-blue bottle covered with trees and flowers, on a metallic lustre, that is simply wonderful, and as yet remains unimitated. It has the density of the richest marble, wherein the longer you gaze the deeper and more glorious is the effect, and the surface is perfect. No. 945 just by is pale, but good. Manufacturers will also observe a plate made of glazed earthenware with white ornament on drab ground; it is as if diaper lay upon the glazed material, and one feels inclined to raise it or ruffle it. This brown metallic lustre is a rich base for the favourite white blossom which it throws up with much distinct but soft relief, together with the plumage of storks and wings of insects. Waring rightly observes that "the Persians were not good painters"—their forms are not seldom ludicrous, as of cat and buffalo groups; the medallions, more grotesque than appropriate, seen in their banqueting table, monsters wearing the jewellery of ladies, and the like. A fantastic history of manners is here written—a fantastic history of manners is here painted. There are rasping-shoes for the feet of pilgrims, pilgrims' bottles of graceful shape, ewers for the reception of alms adorned with lustred diapers.

In the splendid collection of wall-tiles, the ancients show their marvellous skill. Minton has been able to reproduce some of the lustrous grounds of glazing, but we think that at present there are some which are not yet known to our manufacturers. These

belong chiefly to the thirteenth and fourteenth centuries. Indeed, those of more recent date are of little use to the student, architect, or manufacturer. The Nos. 1511, 1512, 1513, 14, 15-'76 are very choice examples. The first is, two wall tiles, turquoise glazed, embossed with a door-way in which a lamp is suspended, and around it are raised semi-Kufic inscriptions. The second is a pale turquoise glazed, the colour remarkably soft and fine, having also raised Kufic letters; this dates from the tenth century. The third on thick material, is also turquoise glazed, with letters in relief, and the fourth of glazed earthenware, with raised blue semi-Kufic letters on lustred ground, diapered with blue and white flowers, and having inscriptions along the top and bottom. The last is of glazed earthenware, with raised semi-Kufic letters on lustred ground, diapered with blue and white flowers, and is of the thirteenth century. The lustre of this specimen is singularly bright. The visitor cannot fail to notice two fine productions (Nos. 1526 and 1527-'76). They are both of glazed earthenware, with raised Kufic letters. The first has flowers on a lustred ground, diapered with white leaflets, and is from the Mosque at Koun, of the date of about 1050, and the other has flowers, and a doorway in which a lamp is suspended on lustred and diapered ground. This is from the same mosque, and is of the same date. Both are the gift of M. Richard. By the way, one cannot avoid commending the tact by which many of these have been acquired. They are among the most sacred articles of the country, and certainly would never have been bestowed upon any Christian nation for any purpose. Later on, the seventeenth century, wall-tiles assumed a pictorial character. Nos. 623, 624-'68, are supposed to be portraits of Shah Abbas II., who is represented on horseback with a hawk upon his hand, but the portrait lacks all that pictures should possess. The specimens from Cairo are also deserving notice; they are all of Persian manufacture, and one especially has fine flower ornaments.

The Musical Instrument Division contains but ten examples, but they are of much value. The venerable dulcimer "Santer," made of wood and painted with a concert of female musicians, has eighteen sets of wire strings, and a pair of hammers, exactly like the quaint object that may now and then be met with in the country. This has a textile case painted, representing a musical entertainment, and rows of soldiers. It comes down from unrecorded time; it is "old Persian." At the bottom of this group of instruments is an old Persian drum, richly covered with Shiraz mosaic. Above are guitars of extraordinary construction, but astonishing workmanship; one, the gift of Sir Fred. Ouseley, has the body and neck covered with minute mosaic, and the legs of turned ivory (No. 940-'73).

Near to this are the cases which contain the books and MSS. A bibliographist will look with astonishment at No. 674, a manuscript on paper of the fifth and sixth vols. of the "Roozet-Essafa," having its two first pages illuminated in gold and colours, and all the pages having ornamental borders. The two first pages are within the border gold, and the writing is executed upon that material in colours at a prodigious expense of labour. The gold, although laid on 400 years ago, is perfectly bright and untarnished. The cover of black leather is elaborately tooled inside and out. Next to it is placed a folio of 66 pages of calligraphic writing in gold letters, two pages illuminated in blue and gold, and all the others illuminated.

The transition of history is seen in No. 679, a small book of 120 leaves of paper written in Kufic black, and the differing form of words added in red for Arabic. There is a little one below it of the ninth century; a MS. on ninety-nine leaves of *paper*, in Kufic letters, having a brown leather cover tooled: so that the arts of book-binding and paper-making of a very respectable type indeed, were known and practised when Alfred here was king. Again, the paper-maker would like to see a small MS. book of thirty-nine pages, containing the various ancient alphabets for the instruction of the "old Persian" students. Its date is of course much more remote. The bookbinder will see a good specimen of sunk gold tooling of *the same period* in a book-cover with stamped arabesques on both sides, coloured and gilt (No. 687-'76), and in No. 695-'76, containing sixteen pages of Khatai paper written on by the calligraphist, Mir Ali, with *marbled margins*. These must have been done by hand. It is bound in leather stamped with a block, 8vo., containing a design of wood scenery on both sides different, gilt on the outside, and pierced. They must have had presses as powerful as an arming-press. Again (699-'76), there is an octavo written on Douletabad paper with illuminated vignettes. This is in leather binding with sunk arabesques, the inside similarly ornamented. To these we might add several other book-covers of that date, but space cannot be given.

The Arms and Armour are interesting to the antiquary; but, beyond the knowledge of metallurgy displayed in that and the metal-work department, there is not much to gratify the practical man. Some of the examples have been sent to Birmingham on loan, and good use will be made of them there.

The notice we now conclude has necessarily been brief; but sufficient may be gathered to prove the benefit of the service thus rendered by the South Kensington Museum to the cause of practical and decorative art. The collection has long been accumulating abroad, and it now has a special locality in the building. No hasty glance will repay a visitor, and a thoughtless one will be disappointed, but the painstaking lover of art will not grudge his time, and he will most surely be compelled to reflect as he observes these relics of a date when we had scarcely begun our marvellous course of civilization. W. S. C.

MR. BARNETT'S SCHEME FOR A NEW THAMES BRIDGE.

MR. FREDERIC BARNETT has recently brought forward a scheme of a very remarkable kind, for a bridge across the Thames below the present London Bridge. Viewed in ground plan, it seems scarcely adequate to the requirements of so busy a river, where multitudes of ships and barges are passing all day long; but as a novelty, it is worthy of the attention of all concerned in such matters—engineers, shipowners, wharfingers, the Corporation, and the public generally.

We need not detain the reader with any details connected with the plethora of traffic over and near London bridge—the newspapers have been full of the subject for some months past. During the busy hours of the day 1,700 vehicles and fivefold that number of foot-passengers cross the bridge per hour, causing a block at each end most difficult to deal with. Some engineers have proposed plans for widening the bridge; but to this it has been objected that such widening would not remedy the evil, because, although it would admit a larger number of vehicles to be on the bridge at any one time, it would not increase the facilities for approach and departure. Tooley Street, Borough High Street, Gracechurch Street, King William Street, &c., would have a greater amount of traffic poured into them without a corresponding increase in the number or width of arteries. Mr. William Haywood, engineer to the City Corporation, has for seven or eight years strenuously urged this view. Widening London bridge, fostering increased traffic over Southwark and Blackfriars bridges, tunnels, steam ferries, all have their merits: but, "sooner or later, a new bridge must be built, whatever be its cost."

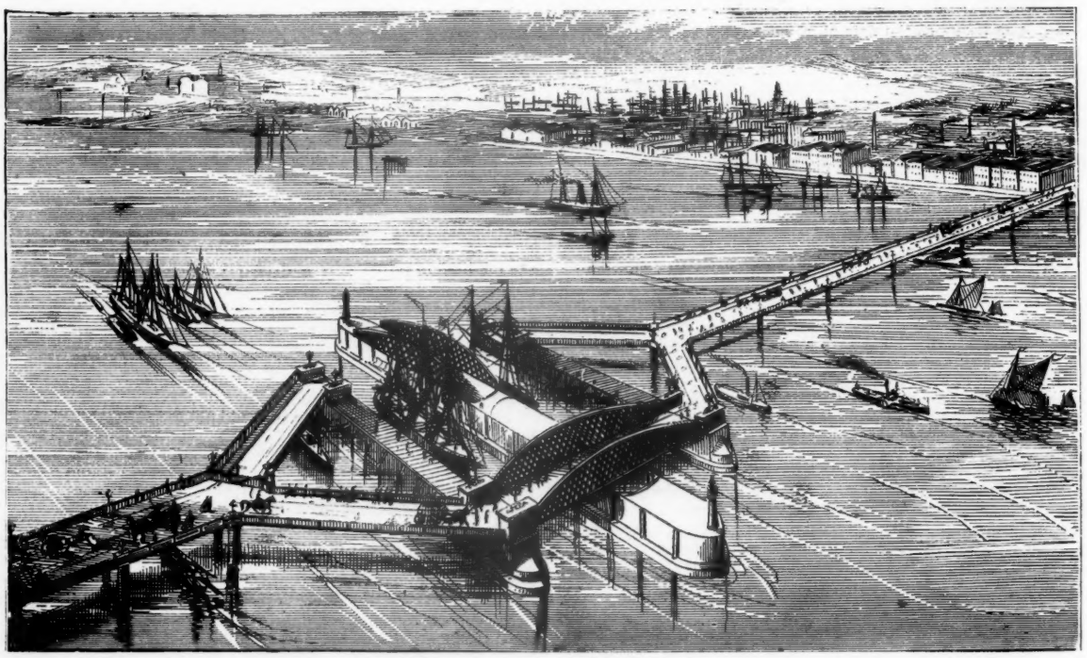
Supposing a new bridge to be built somewhere down in the neighbourhood of the docks—the London and St. Katharine's Docks on the one side of the river, the Surrey and Commercial Docks on the other—it has generally been supposed that this must necessarily be a high-level bridge, permitting passage to large ships with masts a hundred feet high. A low-level bridge with a swing opening in the centre, to allow ships to pass at certain hours of the day, would never suit in such a locality; when the swing was open the road traffic would be stopped—when the swing was closed the river traffic would be stopped. If a high-level bridge were built, with arches so lofty as to permit masted ships to pass beneath them, the land approaches at moderate gradients would have to begin at something like half-a-mile from the river shore, at places most inconveniently situated for the wharfinger and warehousing establishments. The only other apparent mode of using a high-level bridge would be to provide gigantic hydraulic lifts and platforms, to raise vehicles from the level of the streets to that of the bridge. Engineers could, of course, surmount this difficulty, but it would be a very slow mode of transit where vehicles are numerous.

In view of these several difficulties, Mr. Barnett has thought out and patented a scheme of his own. His idea is that of a bridge "that may be built in any part of the Thames with easier gradients than any present bridge." It would allow, in the usual way, a clear passage for barges, steamers, and other small craft, and in addition to this, it would afford facilities for the passage of large ships bearing lofty masts, without stopping for one minute the road-traffic over the bridge. This is a seeming contradiction, but the reconcilement of the anomaly constitutes the peculiarity of the scheme. Let us imagine a bridge stretching across from the Middlesex to the Surrey shore, not differing much from the existing bridges in elevation or in the width of the arches. The bridge, after extending one-third across the river, bifurcates or splits into two, one branching diagonally to

the right, the other to the left. The two branches, changing their angle of direction, would gradually approach again, until they meet at a point two-thirds across the river, from which point the re-united bridge would proceed on to the Surrey shore.

The engraving given below is a bird's-eye view of such a bridge. There is a straight portion from the Middlesex shore extending one-third across the river; there is a similar straight portion extending one-third across from the Surrey shore; while, occupying the middle third of the river, is a diamond or lozenge-shaped portion, forming two bridges. But if all the four angles of this diamond are connected, so as to give continuous roadways, how are ships to find their way through? This question is answered as follows. We have spoken of a diamond-shape, but the construction would probably more nearly resemble an oval, with the long axis across the river. In the centre of the river the two sides of the oval admit of being opened, one or both at a time; they are platforms, or swing-bridges, each turning on its own centre. The width of the oval is more than equal to the length of the largest ship that comes up the Pool. An east and west permanent platform bisects the oval. Supposing a ship to be coming up the river, the road traffic is stopped over the eastern half of the oval, but allowed to continue unimpeded over the western half. The east swing-bridge is turned a quarter round by means of a turn-table built in the centre of the river; the ship enters, and is moored for a few minutes alongside the central platform; the east swing-bridge is closed again, and road traffic over it resumed; the west swing-bridge is then opened, and the ship steams out, or is towed out, of the oval basin in which it has been temporarily enclosed. Narrow lighters, rising and falling with the tide, keep the ship from chafing against the central platform. In coming up the river a ship takes the south side of the platform, in going down it takes the north side, in both cases going what mariners call "port," or "larboard."

It is evident that the practical supervision of such a bridge must be vigilant and perpetual. Some controlling authority



PROPOSED NEW THAMES BRIDGE.

must possess the power of determining which ships shall pass through at once when many are waiting for permission—whether first come first served, or upon any other plan. There must be an understanding whether, when a ship arrives at the bridge, it has to await periodical openings of the turn-table swings, or whether admission is to be given at once. Lastly, there must be engineering appliances at all times ready to open and close the turn-table swing platforms, whether by steam power, hydraulic power, or men working windlasses and capstans. As to the bridge itself, the construction may be either of masonry or of iron, with arch-top or square-top openings; in Mr. Barnett's sketch-drawing, we have a trellis girder bridge resting on iron cylinders.

Among the arguments in favour of the plan, the designer claims (1) that Sir John Rennie's beautiful London bridge need not be disfigured by any of the numerous methods suggested for widening it; (2) that there would be no necessity for a high-level bridge admitting tall-masted ships beneath the arches, and requiring approaches extending to a great distance from the river side; (3) that there would be no need for another Thames Tunnel, with the costly addition of circular screw roadways for the descent and ascent of laden vehicles; (4) that the new bridge may be built in any part of the Thames—the Upper Pool, the Lower Pool, or elsewhere; (5) that it may have easier gradients than those of any existing Thames bridge save and except Waterloo; (6) that the road-traffic across the new bridge need not be stopped for a single instant by the passage of ships, seeing that only one side of the oval will be open at any one time; (7) that no vast amount of compensation would have to be paid to the owners of wharves and other river-side property, because the absorption or destruction of such property would not be more extensive than for an ordinary bridge; (8) that it would benefit the population east of London bridge (estimated at a million and a quarter of human souls) in a far greater degree than any tinkering up of Rennie's bridge.

In a discussion before the Society of Arts, following the exposition of Mr. Barnett's scheme, Mr. Campin urged that there would be great difficulties in the constant use of a swing-bridge, owing to the great number of ships that would require to pass. Mr. J. Jones wished to postpone the scheme (while speaking favourably of it) until the effect had been ascertained of throwing open Waterloo bridge toll free, as a means of diverting some of the traffic. Mr. Tate expressed a fear that the oval, or lozenge, in Mr. Barnett's bridge, would occupy too much space in so crowded a river. Mr. Usill, C.E., was doubtful whether the piers on which the swing-bridges turned would not offer more obstruction to the tidal flow than was desirable, to that extent frustrating one of the purposes for which the Thames Embankment was constructed, *e.g.* increasing the scour of the river. Captain Townshend, R.N., pointed out certain matters which would have to be maturely considered. If the bridge were situated below the docks, would not the number of ships passing through it be too great to be adequately accommodated? Seeing that the tide in the Thames runs about four knots an hour, and that a vessel must go six knots with the tide in order to get good steerage way, would not the head of the vessel run great danger

of smashing against the inner, or second swing-bridge, after entering the lock? If these queries were satisfactorily answered, he considered the plan to be an ingenious one in other respects. Mr. Barnett, in replying to the various objections and suggestions, expressed an opinion that the new bridge would be best placed a little below the Tower; that on an average not more than six vessels per day would have to pass through the bridge [surely this must be erroneous]; that possibly this bridge might be left open for a time after one o'clock in the morning, the road-traffic being stopped, and fish-laden vessels free to ascend to Billingsgate; that the time of passing through the bridge need not exceed five minutes; that the passing of vessels might generally be managed at nearly high or nearly low water, when the flow of water is not so swift as at full ebb or full flood; that if it were to be a free bridge, the City Corporation or the Metropolitan Board of Works, or both acting in conjunction, would probably undertake the work; that if it were to be a toll bridge, the traffic would probably be sufficient to justify the formation of a joint-stock company; that although the loop, oval, lozenge, dock, or basin, would extend 400 ft., a compensation would be found in the fact that the piers would be very useful as landing-stages for steamers; that the bridge would not cost more than £250,000, and that much of this would be returned in the enhanced value of ground at the two ends of the bridge.

Mr. Barnett's plan has to pass through the ordeal of engineering, navigation, financial, and corporate criticism. Meanwhile, our readers will not be sorry for this opportunity of learning in what way it differs from customary schemes for bridge-building.

PREPARATION AND PURIFICATION OF WATER.

AT the Voslau worsted spinning factory near Vienna, the water both for feeding the boilers and washing the wool has been for two years prepared according to the method of Messrs. Berenger and Stingl, by means of a solution of hydrate of lime and caustic soda. M. Kalmann, of the Vienna Polytechnic School, having had opportunities of observing the efficacy of this method at the above establishment, and analyzed specimens of the water both before and after preparation, gives the following results of this analysis; 10 parts of water contain—

	Before.	After.
Lime	1·2655 part	·0388 part.
Magnesia	·8324 „	·1340 „
Oxide of sodium	·0305 „	1·2441 „
Oxide of iron and alumina	·0060 „	·0048 „
Carbonic acid	1·3608 „	·0298 „
Sulphuric acid	·8834 „	·9116 „
Chlorium	·1458 „	·1829 „
Silicic acid	·1130 „	·0606 „
Loss in the fire	·0355 „	·0333 „
Residuum	4·6729	2·6399

From these results it follows by deduction that 10 parts of water contain—

	Before.	After.
Carbonate of lime	1·9294 part	·0693 part.
Carbonate of magnesia	·9772 „	—
Sulphate of magnesia	·9238 „	—
Sulphate of lime	·4492 „	·0010 „
Chloride of magnesium	·1483 „	—
Chloride of sodium	·0577 „	·3015 „
Oxide of alumina	·0060 „	·0048 „
Silicic acid	·1130 „	·0606 „
Magnesia	—	·1944 „
Sulphate of soda	—	1·6181 „
Organic substances	·0355 „	·0333 „

From this analysis it results that by the preparation the water has been freed, even to the smallest quantity dependent on the solubility of the salts precipitated, of all the substances that rendered it hard. This water thus prepared leaves, after having been used two or three months for feeding boilers, a very small quantity of slimy deposit, which is removed by repeated washing, while before purification it formed after only a fortnight a very tenacious and adhesive incrustation which had to be removed with a chisel.

M. Kalmann made a comparison between this incrustation and the slimy deposit. The following are the results of his analysis: 100 parts of these substances, previously dried at 198° Fah., contain—

	Incrustation.	Slime.
Lime	23·933 per cent.	23·05 per cent.
Magnesia	25·850 „	43·00 „
Oxide of iron and alumina	1·765 „	5·20 „
Sulphuric acid	30·329 „	2·95 „
Carbonic acid	7·327 „	17·50 „
Silicic acid	1·101 „	5·09 „
Soda	— „	1·75 „
Loss in the fire	9·524 „	1·60 „
	99·829	100·14

Whence the following substances are deduced:—

	Incrustation.	Slime.
Sulphate of lime	51·556 per cent.	1·19 per cent.
Carbonate of lime	4·832 „	40·06 „
Carbonate of magnesia	9·929 „	—
Magnesia	21·122 „	43·00 „
Oxide of iron and alumina	1·765 „	5·20 „
Silicic acid	1·101 „	5·09 „
Sulphate of soda	—	4·00 „
Loss in the fire	9·524 „	1·60 „

These analyses prove that the slime is composed almost entirely of carbonates of lime and of magnesia, substances which, by virtue of their solubility, though feeble, remain partly in solution in the prepared water.

By the use of a solution of hydrate of lime and caustic soda for preparing and purifying the water, not only are the carbonate and the sulphate of lime precipitated, but also a great part of the salts of magnesia, without leaving in the water the least excess of lime, which, according to the researches of Messrs. Stingl and Fischer, causes very tenacious and dangerous incrustations. Moreover, water so prepared never contains in solution any substance capable of attacking the plates of the boiler, which is a great advantage, for M. Wagner has proved that certain salts in solution, especially chlorides, do very soon attack them.

Water prepared by the above method is used for feeding steel plate boilers, among others, at Voslau, without any perceptible inconvenience. *Abridged from Dingler's Politechnisches Journal.*

Chemistry applied to the Arts, Manufactures, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

§ 1. *Acids, Alkalies, and Salts.*

DETECTION of Small Quantities of Free Mineral Acids in Vinegar.—According to the experiments of M. WITZ, methylaniline violet may be advantageously employed as a reagent for the detection of small quantities of free mineral acids in vinegar. Acetic acid is by itself without effect on the above violet, but mineral acids (muriatic acid, sulphuric acid, and nitric acid) turn the violet to bluish-green, if it occurs in the smallest quantity in any fluid. Hence it follows that vinegar, whether natural or manufactured, will immediately change the violet if any trace of mineral acids has been put into it. M. Witz considers this experiment of great importance, as in no other way can the adulteration of vinegar be detected with such facility and certainty. *Polytechnisches Blatt.*

Manufacture of Salt and Bromine in the United States.—In the valley of the Ohio the manufacture of salt and bromine has been remarkably developed the last few years. The salt is found by analysis to be the purest of those met with in America, and is well suited for domestic purposes, owing to the absence of every calcareous salt.

The salt water is obtained by digging wells 260 to 390 yards

deep through a soil in which rather hard rocks and two beds of coal are met with. The water is first pumped into a wooden cistern, where it is left to rest. It is then poured into iron boilers, and boiled till crystallization begins. After this it is conveyed into wooden chests in which copper pipes 2½ in. to 4 in. in diameter keep up a constant temperature. The crystallized salt is deposited at the bottom of the chest, and after drying for twelve hours is packed and ready for delivery. The salt on analysis yields 97·5 per cent. of chloride of sodium, 2 of moisture, and ·5 of foreign substances.

Coal is found in these parts, as well as natural gas. On the river Kanawa, where salt is manufactured, the gas is abundant enough to be employed for boiling the salt water.

The mother lye is heated to obtain bromine, which is an important article of commerce much used in medicine, chemistry, dyeing, and photography. Six factories are employed in its preparation.

§ 2. *Metallurgy.*

Extraction of Gold and Silver from exhausted Electro Baths.—Pour exhausted baths, or liquids poor in gold, into porcelain vessels, and boil them. Add a solution of protoxide of tin combined with soda, and continue boiling till all the gold in combination with the tin is deposited in the form of a deep black precipitate, which is to be lightly washed and then dissolved in aqua fortis. The resulting liquor is composed of a mixture of perchloride of gold and perchloride of tin. Evaporate it with care, dilute it with distilled water, and add a sufficient quantity of tartrate of potass with soda. Heat the whole, and even the smallest fraction of gold will be seen to separate in the form of a yellow-brownish very light powder, while the tin remains in solution. With the combination of cyanogen (or bicarburet of nitrogen) containing silver, it is sufficient simply to continue boiling while adding the protoxide of tin combined with soda, to set free the slightest traces of silver. *Technologiste, April* 1, 1876.

Production of Silver throughout the World.—According to the most recent statistics the production of silver throughout the world in 1800 amounted to £7,000,000; in 1850 it rose to £8,500,000; and in 1865 to £12,500,000. The production of this metal in the year 1873 was divided as follows:—England and its colonies £2,000,000; Austria, £320,000; Germany, £600,000; Norway, Sweden, and Denmark, £50,000; Russia, £100,000; France, £400,000; Spain, £400,000; Sardinia, £100,000; Mexico, £4,000,000; Central and South America, £1,600,000; Canada, £1,800,000; United States, £7,300,000; making a total for the year 1873 of £17,050,000.

It is calculated that, including that year, the total production of silver since the discovery of the New World by Columbus has been £143,000,000. The greatest increase in the production of this metal of late years has been in the United States, in the State of Nevada. *Moniteur Industriel Belge, March* 20, 1876.

Electro Deposits.—Prof. KICK, of Prague, has published some important results of experiments in the formation of electro deposits. According to him, uniform and tenacious metallic deposits may be obtained with strong as well as weak currents, if the decomposing fluid or electrolyte is rightly selected. For a copper deposit on old bed-dies not affected by the fluid, a solution of copper with an addition of sulphuric acid to 7 per cent. is most suitable. The best bath is produced by a solution of sulphate of copper or blue vitriol 15° to 20° Baumé, strengthened with sulphuric acid 1° to 2° Baumé. To obtain a firm adherence of the metal coating, especially silver on brass, the cathode or negative pole must first be changed to the anode or positive pole for a short time, and the current afterwards changed. For coppering iron, mix one part of copper solution about 18° Baumé with 4 parts of water, and add one-eighth of a part of sulphuric acid. Well-cleaned iron need only be dipped in this fluid for an instant to be covered with a firm coating of copper. *Maschinenbauer.*

Casting Mixtures of Pig and Wrought-Iron.—Mr. W. HOLDSWORTH, of Pittsburg in Pennsylvania, has lately made known a method of making good castings with pig and wrought iron in combination. For this purpose he mixes pig and wrought iron together, slightly varying the proportions according to the quality of the materials he employs, increasing or diminishing the per-centage of wrought iron according to the greater or smaller quantity of carbon which the pig-iron contains, or according to the degree of malleability or hardness he wishes to give to the product.

When ordinary articles are to be cast and for ordinary purposes, equal quantities of wrought and pig-iron may be taken, merely increasing the wrought iron from 10 to 20 per cent. and diminishing the pig-iron as much as 25 per cent.

The fusing may be done in any oven or furnace, or in a crucible, and such ingredients added as are thought suitable; but to facilitate the mixture and fusion, the materials should be reduced as far as possible to small fragments. As soon as the mass is fused, it is formed into pigs in the usual way. The pigs are then broken, and again fused in the crucible or on an open hearth, or in the cupola smelting furnace; and as soon as the material is fused it is poured into the ordinary moulds. This second fusion produces on the iron a refining effect, while at the same time it gives the mixture greater homogeneity. This fusion may even be repeated, with the addition of a small percentage of wrought iron, *e. g.* 5 to 10 per cent. In this way is obtained a cast product which possesses nearly all the properties of ordinary wrought iron, and is consequently resisting, tenacious, malleable, and ductile.

Process for Tinning Wire.—First scour the wire with hydrochloric acid in which a piece of zinc is suspended. Then put this scoured wire—after bringing it into communication with a sheet of zinc—in a bath of two parts of acetic acid, and 100 parts of water, to which bath add three parts of a salt of tin (chloride of tin) and three parts of soda. The wire should remain about two hours in the bath. It may then be made bright by polishing or drawing at the draw-bench.

Iron wire rolled in a spiral or pieces of iron of various forms may be whitened by this process, which is an advance upon mechanical methods of tinning the wire hot, and then drawing it at the draw-bench. *Wochenschrift der Nieder-österreichischen Gewerbe-Vereines.*

The Properties of Bronze Mechanically Treated.—Herr KÜNZEL, of Dresden, in a work which is the fruit of long researches, gives an account of the properties of bronze that has been subjected to mechanical treatment. With all the resources which science and industry supply at present, it is ascertained that ordinary cannon bronze merely cast offers an absolute resistance of about 35,000 lbs. per square inch, and a limit of elasticity of about 25,000 lbs. These results are very important for industry, and the more so, because this capacity for resistance of pieces cast in bronze is nearly constant. This was sufficient as long as guns were required to bear comparatively light charges, as was usually the case up to 1870; but as since then a much greater power has been required for pieces of artillery, both large and small, cast-iron guns hooped with steel no longer offer sufficient resistance, nor does ordinary bronze suffice. It has therefore become necessary to increase the resisting power of bronze, especially its hardness and elasticity, so that it may compete with steel.

As this was not possible either by altering the composition of it or employing different processes of casting, even with phosphoric bronze, which is the best in every respect, it was necessary to seek the accomplishment of the object by means of mechanical treatment.

As steel and iron acquire their maximum of resistance by hammering, rolling, and drawing, so it may be necessary for bronze to undergo mechanical action. Since the end of 1870 Herr Künzel has been engaged in the solution of this important problem, and the principal conclusions to which the results of his experiments in hammering, rolling, and drawing phosphoric bronze, have led him, are the following:—

1. Hammering, rolling, and drawing cold, may give bronze the hardness of steel.

2. The annealing of hammered, rolled, and drawn bronze makes it lose the superficial hardness and elasticity, but the absolute resistance and tenacity of bronze thus beaten, rolled, drawn, and annealed are always greater than those of raw bronze. The mechanical working, therefore, causes a molecular change in the latter which is favourable to the development of absolute tenacity, elasticity, and resistance. These changes are permanent, even after the annealing.

3. The resistance of bronze forged cold and then heated to a fixed temperature, corresponds exactly to the latter. The losses of hardness artificially developed, absolute resistance, and elasticity are, like the increase of tenacity, greater in proportion as the temperature is higher. Thus the re-heating of hardened bronze to 410° Fahr., that is to the temperature at which tin is fused, causes no perceptible change in the resistance produced by hammering cold.

4. When phosphoric bronze containing 5 per cent. of tin is forged, greater absolute resistance and tenacity than those of cast steel may be communicated to it.

5. Bronze containing more phosphorus, with 5 per cent. of tin, forged and hardened, and then heated to 500° Fahr., possesses double elasticity and an absolute resistance and tenacity more

than double those of the best ordinary cannon bronze with 10 per cent. of tin.

6. Few manufacturers are able to produce steel suitable for making cannon, so that governments are at the mercy of a few for their armament, while on the contrary it would be very easy to make cannon of phosphoric bronze forged. Besides, this latter offers, for equal absolute resistance and elasticity, more securities than steel against the chances of bursting, on account of its superior tenacity. It possesses, moreover, properties of resistance to the inclemencies of the air, and even—as experiments at Woolwich have shown—a very superior power of resisting the destructive influences of the gases of gunpowder.

7. Lastly, with bronze cannon, after their destruction a great part of the cost will always be recovered by the sale of the metal, while steel cannon unfit for use are of little or no value in comparison with their cost. We may therefore conclude that cannon made of phosphoric bronze with a small proportion of tin are in every respect preferable to those made of steel. *Deutsche Industrie-Zeitung.*

Production of Gold and Silver in the United States.—In 1875 the western states of America, California, Nevada, and the gold districts added to the gold in circulation 49,214,087 dollars. The production of silver in Nevada, California, Utah, Colorado, &c., amounted to 31,574,950 dollars. The total production of gold and silver during the last five years has been as follows :

	Dollars.
1871 . . .	56,284,000
1872 . . .	62,236,959
1873 . . .	72,258,693
1874 . . .	74,401,045
1875 . . .	80,889,037

It is calculated that in 1876 Nevada alone will produce at least fifty million dollars.

Cheap Silvering on Stone and Plaster.—Take two sheets of mica, and render them perfectly white by boiling in hydrochloric acid or by the action of fire. Wash them and dry them, then bruise them to fine powder, and sift it. Mix the powder with very light collodion, and then, with a soft camel-hair brush, put two or three layers on the object. As soon as it is dry, it will assume and preserve the appearance of silver.

Metalliferous Beds in Sweden.—The works of the Nora and Karlskoga Railway in Sweden are pushed forward with great activity, and part of the line will be worked in June. The railroad passes through districts very rich in iron ores of great purity, which in some places are found even at the surface of the soil. The beds are very powerful. At a depth of 590 ft. it has been found that the ore does not vary either in quality or extent. It is calculated that millions of tons of black magnetic oxide may be got. This ore, according to several analyses, is composed as follows :—

Silicium	9·56 per cent.
Oxide of iron . . .	73·51 „
Alumina	·70 „
Lime	3·32 „
Magnesia	6·14 „
Oxide of manganese . .	4·42 „
Sulphur	·58 „
Phosphorus . . .	·07 „
Carbonic acid and waste .	1·70 „

The 73·51 per cent. of oxide of iron contains 52·23 per cent. of pure metal. It is expected that England will derive great advantage from the mines when the railway is completed, and the Swedish ironmasters consider the enterprise unfavourable to their interests.

Iron Plates for Italian Men-of-war.—The largest armour-plates hitherto made have been drawn in the workshops of Messrs. CAMMELL and Co., at Sheffield. They are 23 in. thick, that is, more than 9 in. stronger than any yet known, and are intended for two Italian men-of-war, the "Dandolo" and the "Duilio," built at the docks of Castellamare and Spezzia. These two vessels are provided with two turrets, each of which is to contain two 100-ton guns, like those recently manufactured by Sir W. Armstrong at Newcastle. They are 30 ft. long, with an external diameter of 19 in. Their projectiles weigh nearly a ton. To give an idea of the enormous quantity of metal which enters into the composition of one of these plates, we may mention that the bloom, or slab, remained in the furnace twenty-seven hours before being carried to the rollers. The plate weighs 35 tons, and measures 17 ft. long and 5 ft. broad. The rolling of such a piece is a marvel. When it was completed, in the presence of Sir Joseph Whitworth and some representatives of the government, Mr. Cammell said he would not hesitate in future to manufacture plates 30 in. and even 40 in. thick, if these did not resist Whitworth guns of the greatest bore.

Sulphuret of Tungsten.—According to RICHE, if sulphur is fused with acid tungstate of potass or of soda, and the product washed in water, there remains sulphuret of tungsten in the form of very fine crystals of a bluish-black colour. On paper they leave traces like those of graphite. When pressed between the fingers they easily collect together. This substance might perhaps serve as a substitute for graphite in the manufacture of pencils and for electrotyping.

Manganese and its influence in the Metallurgy of Iron and Steel.—The incompatibility of phosphorus and carbon in steels is a fact of importance first observed at Terrenoire, and afterwards at two factories in Germany, where they succeeded in rolling metal decidedly phosphoric, but soft. To this incompatibility must be added that of carbon and silicium.

The malleability and fusibility of metal essentially depend—all other things being equal—on the quantity of carbon contained. The greater this is, the more fusible is the metal and hard to roll. Foreign substances, such as sulphur, silicium, phosphorus, and manganese, may affect certain properties of iron, but they do not modify its special character. The following positions may be laid down with regard to the influence of phosphorus and silicium. In presence of a considerable quantity of carbon they render the metal intractable when hot. If the quantity of carbon is inappreciable, the metal may remain ductile, even though charged with considerable quantities of phosphorus and silicium, the limit of which is supplied by the necessity of resisting shock.

It was thought that silicium had the effect of rendering iron brittle when hot, by giving it a peculiar fracture. But free silicium does not and cannot exist in iron, on account of its ready oxidation. It is the interposed scoriæ that make the iron break when hot. M. MRZACK introduced into fused metal, containing but little carbon, metallic silicium, which did not prevent the metal from acting well when hot. It is, therefore, by mistake that properties have been attributed to silicium which belong to the silicates.

Manganese, according to M. Mrzack's experiments, does not behave at all like phosphorus and silicium. It fears carbon less than these metalloids do, and differs from iron only by a greater affinity for oxygen. With this it forms alloys, of which ferro-manganese is the type. *Revue Universelle des Mines.*

Extraction of Copper from the residues of the Roasting of Poor Pyrites.—M. JEZLER, in his experiments on the extraction of copper from roasted pyrites, employed pyrites from Borsa Baenya, in Hungary, which contain, besides small quantities of silver, lead, magnesia, and soda :

Iron	35·83
Copper	1·01
Arsenic	2·50
Lime	2·80
Silicate of alumina	12·52
Sulphur (in the state of sulphurets) .	39·65
Sulphuric acid	1·60

The agent he employed to extract copper from the residue of the roasting of these pyrites was hydrochloric acid, or rather chloride of iron, with the addition of hydrochloric acid. The immediate treatment of the residue does not give satisfactory results. It is necessary first to leave these residues exposed to the air, in which, under the influence of the oxygen and moisture, they break up till only fragments occupying small space are left. The smallest part, separated by a sieve, is treated with hydrochloric acid. Chloride of iron is formed, which, acting on the inferior sulphurets of copper, attacks and oxidizes them, and changes to perchloride of iron.

At the same time with the copper, silver and lead, the proportion of which is very small, are also dissolved. The possibility of dissolving silver and lead in a hydrochloric and sulphuric solution is well known. But lead in a large quantity remains in the residue insoluble, the temperature necessary to produce solution having never been reached.

Roasted pyrites give up to water alone a considerable quantity of sulphate of alumina, arising chiefly from the disintegration of the gangue. Hence it is better to exhaust the residues by water first.

Copper and other metals are precipitated from the solution by iron, and the metallic deposit is sent to special manufacturing establishments. *Dingler's Polytechnisches Journal.*

§ 3. *Dyeing, Calico Printing, Bleaching, Tanning, and Allied Subjects.*

Dyeing Wool in Scarlet, Salmon, and Rose Colour with the Same Bath.—M. F. SPRINGMÜHL gives the following receipt for a scarlet bath which will also produce salmon and rose colours. The scarlet dye is produced by a liquid composed as follows for 110 lbs. of yarn :—

11 lbs. of cochineal of good quality,
3¼ lbs. of salt of tin,
6¼ lbs. of oxalic acid,
11 lbs. of Dyer's spirit,
¼ lb. of flavine.

Boil for a quarter of an hour, then let it cool, and you have a scarlet dye into which the yarn is to be dipped. Then boil gradually, and keep up the boiling for an hour.

If 5½ lbs. of oxalic acid and 2¾ lbs. of salt of tin be added, boiled for a quarter of an hour, and then cooled, salmon colour may be obtained by treating the yarn as above.

If to this second bath 6½ lbs. of Dyer's spirit, and 4½ lbs. of cochineal be added, then boiled, and suffered to cool, the yarn may be dyed a deep rose colour. If, lastly, 3¼ lbs. of Dyer's spirit be added, the yarn will have a bright rose colour. If too much flavine is used with the first bath, the rose tints cannot be obtained.

Dyer's spirit is thus prepared :—

6 gallons of water,
33 lbs. of acetic acid,
2¾ lbs. of hydrochloric acid,
6 lbs. of grated tin, which is added in small quantities.

Technologiste.

Arnotto Yellow on Cotton.—Arnotto is one of the few colouring matters which can be applied to cotton fibre directly without a mordant, and which are extensively used for cotton printing and dyeing in general. The ordinary methods of applying it are attended with some uncertainty and inconvenience. Sometimes the yellow is too bright or too deep, sometimes pure yellow or reddish yellow, and moreover, the colour will not always stand well.

M. KIELMEYER has observed that a mixture of alcohol and a soda lye dissolves the yellow and red ingredients of arnotto much more completely than either of these solvents alone. Hence he has sought and found a new formula for the yellow of arnotto, which practice has confirmed. It requires only half the lye necessary with other formulæ, while it ensures the duration and permanence of the printed colour by reducing to a minimum the injurious influence on the browns and reds, and by brightening the yellow colour.

He puts 66 lbs. of arnotto in 5¼ galls. of alcohol, and adds to it, while continually stirring, 2½ galls. of a soda lye of 1·598 specific gravity. The whole having a temperature of 113° to 122° F., is left for a night in a copper boiler. The liquid is then drawn off, and the undissolved residuum is collected on a metallic sieve, carefully pressed, and treated with 7¾ galls. of boiling water to free it from all solution of arnotto mechanically adhering to it. The watery bright yellow solution, after having cooled, is added to the preceding alcoholic solution, and the whole is thickened with 13 lbs. of gum tragacanth mucilage.

The shade which is obtained on cotton with this printing colour, after evaporation and washing, is a very intense orange yellow, which is not dear, for notwithstanding the use of alcohol, the colour costs less than that prepared by the ordinary formulæ, because it admits of much less arnotto, which is a direct proof that by this treatment of arnotto there is less reason to fear loss of colour by decomposition.

If a brighter shade is desired, with less orange in it and more approaching canary yellow, as for very thin pocket handkerchiefs, aluminate of soda and a decoction of yellow berries are to be added to the diluted colour. The ammoniacal solution of turmeric is not to be recommended, because it cannot be kept in any quantity for more than two or three hours. *Polytechnisches Journal.*

New Vegetable Colouring Matter.—In Tahiti there is a tree of the Musaceæ family, called *Musa Fehii*, which grows chiefly in high places, and the fruit of which is eaten like that of the banana. In the early stages of its growth it yields a sticky, neutral juice, which in a thin layer is strawberry red, and in a thick layer blue violet. It keeps pretty well in a closed vessel, but if allowed to rest long, deposits a violet substance forming threads, and behaving like caoutchouc with solvents. The liquid, after being freed from this substance, may mix in any proportion with water and alcohol without getting thick, and then has so intense a colour that it may be diluted with five times its weight of water without any apparent weakening of its tint. Its taste is astringent, and with gelatine it gives an abundant precipitate which takes away the colour. Weak alkaline solutions make it turn to green, without producing any precipitate. Salts of lime cause an insoluble tannate precipitate, which takes away the colour. Acids make it change to a reddish colour, sulphate of iron produces a beautiful blue precipitate, and acetate of iron a blackish precipitate, like that of tannate of iron. Salts of zinc and copper colour it blue, without producing any precipitate, while acetate of lead gives a violet blue precipitate. Perchloride of tin developes a violet lake of peculiar vivacity of tone.

A trial of this new colour on yarn was made with part of the juice, freed, as stated above, from the caoutchouc substance, and diluted with five parts of water. On cotton treated with alum the liquid produced a pale violet bordering on grey, but on cotton prepared with a solution of tin the violet was very fine. The yarn, being first put into the bath of tin, and then into one of iron, and afterwards dyed, gave a deep saturated brown. On flax the same tints, but brighter, were obtained. Silk prepared with a solution of tin, and put into the dyeing-bath, took a bright grey tint. *Polytechnisches Journal.*

Destruction of Vegetable Substances mixed with Wool.—The wools which come to Europe from the numerous flocks of Australia and some parts of South America, are mixed with a great variety of vegetable substances, and this has long been an obstacle to their use in the manufacture of woollen fabrics. Various methods have been tried for separating the animal from the vegetable substances either mechanically or chemically. Mechanical means, which were first employed, are now generally abandoned on account of the expense, and replaced by chemical agents which exert their influence at fixed temperatures. Vegetable substances may thus be effectually removed from wool even in manufactured articles. The essence of the process consists in treating the woollen fabric with a diluted solution of sulphuric acid 4° to 5° Baumé, and then placing it in a stove heated to 125° to 140°. This is Frézon's method. M. Joly proposed to substitute a solution of hydrochlorate of alumina for the acid solution, and this has been found successful, only it necessitates heating the stove to rather a high temperature.

Messrs. Barral and Salvetat have made many experiments to determine the action of a great number of re-agents, and give the following as the results at which they have arrived :—

1. Cellulose and woody fibre are decomposed under the action of the following chemical agents, provided the fabric, after soaking, is raised to a temperature of about 140°; sulphuric acid, hydrochlorate of alumina, hydrochloric acid, nitric acid, the chlorides of zinc, iron, tin, and copper, the nitrates of copper, magnesia, and iron, the sulphates of tin and alumina, bisulphate of potass, chromic alum, boric acid, phosphate of lime, and oxalic acid.

2. On the contrary, wool is not attacked in the above conditions.

3. The following agents do not destroy vegetable fibre in the same conditions : the chlorides of sodium, potassium, barium, calcium, magnesium, and mercury, hydrochlorate of ammoniac, the nitrates of ammoniac, mercury, lead, soda, barium, lime, and potass, the sulphates of copper, ammoniac, manganese, iron, lime, magnesia, soda, and potass, bisulphate of potass, ammonia, alum, nitrate of alumina, potash-alum, tartrate of soda, chlorate of potass, hypochlorate of potass, oxalate of ammoniac, oxalate of potass, tartric, acetic, and citric acids.

4. The first effect of the agents which have the property of destroying vegetable fibre in the preceding conditions is to take away part of the water from the vegetable substance and carbonize it.

Tungstate of Zinc as a Colouring Substance.—If to a solution of tungstate of soda be added a solution of a salt of zinc, a snow-white tungstate of oxide of zinc is immediately set free, which covers well, and may be especially recommended for fine painting. As an oil colour it is said to be preferable to all white colouring substances. *Polytechnisches Notizblatt.*

A Gold Varnish.—Researches made by M. KAYSER, of Nuremberg, have shown that a gold varnish, distinguished both by its hardness and beautiful colour, may be obtained by the use of picric and boracic acid. A very pure solution of gum lac should be mixed with picric acid and about half per cent. of crystallized boracic acid, the two acids having been previously dissolved in alcohol. In this way a gold varnish may be prepared, possessing all the advantages of those that are met with in commerce. *Technologiste, March* 18, 1876.

The importance of Lime in Dyeing with Madder.—M. ROSENTHIEL has been studying the importance of lime in dyeing with madder and its derivatives. He shows that lime is fixed on textile fabrics at the same time as the colouring substances, and that a beautiful bright red on cotton contains alumina and lime, in the proportion of four atoms of aluminium to three of calcium. Rosenthiel experimented with a solution of bicarbonate of lime in the proportion of a gramme (15¼ grs. troy) per litre (1¾ pt.). Pseudo-purpurine does not hold unless distilled water is used, and its tints are removed by soap. An addition of solution of lime weakens the dyeing bath. If the addition is so strong that a lake is formed with an atom of calcium, all the pseudo-purpurine will be lost and precipitated. Carbonic acid does not re-act on the insoluble lake. This is the reason why pseudo-purpurine is of no importance in dyeing with madder, which always requires the addition of a small quantity of carbonate of lime. Madder from Avignon contains this quantity of itself, but that of Alsace requires some to be added. On dyeing with Alsace madder—that is to say with a mixture of pseudo-purpurine, alizarine, and purpurine—in water free from lime, the pseudo-purpurine is first fixed on the mordant, then only the purpurine. The alizarine scarcely comes into consideration. The colours cannot be firm, being principally formed of pseudo-purpurine, and consequently do not resist soap, acid, and light. By the addition of chalk, on the contrary, the alizarine is first fixed on the mordant, and forms with the purpurine the true madder red, being also that obtained with Avignon madder. The pseudo-purpurine is again found under the form of an insoluble lake in the dyeing bath, and is lost for dyeing purposes, as well as a little of the purpurine and alizarine.

To supply this loss, the madder-dyeing baths are poured into basins apart, where the deposit takes place. The deposit, having been separated, is treated with boiling acid diluted with water. By this process the lakes are decomposed, and the pseudo-purpurine is brought to the condition of purpurine. The final product is garancine of spent madder, and for the most part contains purpurine. It is employed in the form of cakes, and takes the place of garancine, but is naturally of less value. With the hydrate of purpurine a beautiful red may be obtained in a direct way, without the use of a soap bath, which only increases the brightness of the colour.

The hydrate of purpurine, called orange colouring matter, is of no importance for dyeing, which is true of pseudo-purpurine also. Hence the only colouring matters of importance for dyeing are the purpurine and alizarine. It is easy with them to obtain all the shades required. Carbonate of lime is indispensable to the alizarine, which requires the quantity necessary to form alizarate of lime. A larger quantity is injurious, since a combination of two atoms of lime gives a deep violet blue colour, which, being scarcely soluble, has little dyeing power. If a small quantity of alizarine is boiled in water charged with lime, the liquid is coloured violet, and preserves this colour for several days. The purpurine treated in the same way gives a rose colour, which disappears after a few hours.

On dyeing with a mixture of alizarine and purpurine in distilled water, it is chiefly the purpurine that operates, even when the two are employed in equal quantities. If, on the contrary, the water is charged with lime, it is chiefly the alizarine that forms the red, and on the addition of chalk the red becomes more and more violet, while the purpurine is precipitated in the form of an insoluble lime lake.

Consequently there is a means of producing any shade whatever with the same mixture of alizarine and purpurine, by varying the proportions of chalk. This explains why often with the same garancine at one time a red may be obtained (with a small quantity of chalk), and at another a beautiful violet (with a larger quantity of chalk). *Moniteur Industriel Belge, March* 20, 1876.

The influence of Acids in Dyeing with Madder and its Artificial Substitutes.—In a paper on this subject, communicated to the "Bulletin de la Société Industrielle de Mulhouse," M. ROSENSTREHL shows that alizarine and the colours related to it deprive carbonic and acetic acids of their salts, so as to form lakes with simple bases which are themselves decomposed by the same acids. In presence of the oxides of aluminium and iron this deprival is more complete, and extends even to salts with energetic base, such as the nitrates and chloride of calcium. There are then formed lakes with double base.

He also shows the important part which carbonic acid, naturally dissolved in water, performs in the operation of dyeing, indicates the cause of the divergences that exist between the results of experiments in the laboratory and those of industrial operations, and suggests means of putting an end to the disagreement. He proposes the substitution of acetate of calcium for the carbonate, as being more advantageous, and incidentally mentions the peculiar dissolving action which acetate of sodium exercises when hot on the colouring materials of which he has treated.

Walnut Husks.—Though as a general rule good use is made of the materials furnished by nature for purposes of art, some are thrown away as useless through want of thought. To this class belong the green outer husks of walnuts, which have long been known to possess colouring matter, but have not received the attention they deserve. They contain a yellow brown, remarkably fast dye, which is well suited for dyeing woollen and cotton materials, staining wood, &c., and would serve the same purposes as colouring substances on which large sums are expended. Wool requires no mordant, &c., when dyed with them, is very soft to handle, and not like that dyed with vitriol. The dyeing is as simple as it is cheap. The shades of colour obtained are from bright to dark brown, pleasing to the eye, and very fast. In many places the husks may be got for nothing. They may be simply kept dried till used, or packed moist in tubs, by which means their colouring power is further increased. *Muster Zeitung.*

Direct Production of Methylaniline on Cotton.—Methylaniline salts in presence of oxidising agents, such as salts of copper, chlorates, &c., produce Paris violet. These conditions of formation resemble those of aniline black. It might therefore be supposed that violet can be produced by the aniline black formula, aniline being replaced by its derivative. But this is not the case, the violet being destroyed by a further action.

If a solution of neutral chlorate of methylaniline (to 3 or 4 per cent. of the base) or with an excess of base, be printed, a violet colour more or less bright is obtained after an exposure of eight or ten days at a temperature of 86° to 95° F. The addition of one-fourth to a half per cent. of red prussiate brings out the colour in two or three days. The solution of chlorate should not be acid, nor the place of exposure too damp. The addition of salts of copper to the chlorate of methylaniline does not give satisfactory results.

The colouring matter obtained directly on the textile fabric does not differ from Paris violet except in brightness of tone. Boiling water takes away the violet and leaves nothing but grey, a secondary product of the re-action. *Bulletin de la Société Industrielle de Mulhouse.*

The change of Madder Red to Orange.—M. C. STROBEL, while studying the action of nitrous vapours on various printed colours, found that they destroyed most aniline colours and indigo blue, but brightened vapour greens and blues. He then applied them to madder red, and obtained a beautiful orange, which does not turn to red under the action of boiling soap-baths.

The experiment answered as well with vapour reds as with those obtained by dyeing on textures, whether oiled or not. His mode of operation is this. Into a wooden case containing the coloured texture he introduces the nitrous vapours obtained by the action of nitric acid on starch. The gas is previously cooled by passing through a flask surrounded with water. An exposure of four or five minutes is necessary to effect the change of the red. If the operation is interrupted before that time, the orange obtained will turn to brown under the action of soap and alkalies.

M. Strobel's observation is new, and its importance will be appreciated by all who are engaged in dyeing textures. If the process above described cannot be employed in industry now, the time may be anticipated when the substance which produces this beautiful orange can be prepared directly, and applied to textures. We shall then have another fast colour which will not fail to be extensively used. *Bulletin de la Société Industrielle de Mulhouse.*

§ 4. *Food, Water, and Sanitary Matters.*

Means of Preservation from Fire. — Decisive experiments have lately been made at Vienna on processes suitable for preventing fires. These experiments were made on ordinary textures, as well as on materials of great fineness, and on different kinds of building wood, two mixtures of salts being employed, which have been prepared by M. PATERA for preventing the burning of the textures, and the spread of flames.

1. A mixture of borax and sulphate of magnesia. To prepare this, for 20 parts by weight of water take 3 of borax and 2¼ of sulphate of magnesia. The action of this mixture depends on the formation of a borate of magnesia, insoluble in water hot or

cold, which surrounds and impregnates the threads of the texture or the fibres of the wood, and thus renders the development of combustible gases and the spread of flame very difficult.

2. A mixture of sulphate of ammonium and sulphate of lime, or gypsum, in various proportions according as it is to be applied to materials of greater or less fineness. The sulphate of lime is transformed, with the salt of ammonium, into a double compound which produces none of the disagreeable effects of the latter, or at least in a very slight degree. The action of this mixture of salts—which on account of its cheapness may be extensively employed—depends on an incrustation of the fibres, which prevents the spread of fire, and on the other hand extinguishes flame in consequence of the volatilization of the salt of ammonium at a high temperature.

Take one-third by weight of liquid ammoniac and two-thirds of sulphate of lime, and a single coating with a concentrated solution of this compound, which costs little, suffices to preserve wooden structures from burning. The wood is not rendered absolutely incombustible, but it is not easy to light, and ceases to burn when the action of foreign inflammable substances comes to an end.

Roofing often washed with rain water and presenting every condition favourable for easily taking fire was impregnated with this mixture. It had been covered with a layer of tar and drying oil, and thus rendered more liable to burn. Nevertheless all attempts to set it on fire failed. The experiments made have been so satisfactory, that the Austrian Minister of Finance has recommended this method to be used in all the establishments of the empire. *Oesler-Zeitschrift für Berg-und-Hütten-Wesen.*

The various kinds of Camphor.—Ordinary camphor comes from Japan or the island of Formosa, but there are various highly esteemed species of camphor obtained from Borneo and Sumatra. There is also another variety of medium quality produced by the blumea balsamifera, a plant of the composite order, which grows in the east of Asia. The Chinese denote it by the name Ngaï, and make use of it in medicine and the manufacture of ink. It produces harder and more brittle nuts than the laurel camphor. Like this latter it is sublimated at an ordinary temperature, but less easily, while the Borneo camphor does not show any traces of sublimation even after several years.

All camphors float in water, but when the air in the interstices is exhausted by an air-pump, the Ngaï and Borneo camphor sink to the bottom, while the laurel camphor swims. The specific gravity of laurel camphor is ·995, that of Ngaï 1·02, and that of Borneo 1·011. Laurel camphor melts at 355° Fahr., Ngaï at 599°, and Borneo at 405°. Laurel camphor, washed with hydrochloric acid and still moist, quickly changes to a colourless liquid. In the same circumstances Ngaï and Borneo absorb the acid very slowly, and do not turn to a liquid till long after. Nitric acid changes Borneo camphor into an oil which, on the addition of water, deposits a substance identical with laurel camphor. The same thing occurs with Ngaï. *Archiv. der Pharmacie.*

The Influence of Forests.—The influence of forests on the sanitary condition of a country has often been disputed. It is, however, very difficult to admit that extensive woods, which make a great alteration in the moisture and temperature of the air, produce no appreciable effect on health. Popular opinion, anticipating scientific proof on this subject, has always attributed to forests great influence on the sanitary state of the countries in which they are situated, and their destruction has been considered to cause changes in the nature and number of prevalent maladies. The following examples in the Campagna near Rome show that public opinion is right in considering that forests have a favourable effect on health.

At Palo, a station on the line from Rome to Civita Vecchia, the malaria has much increased since a small wood which protected the place from the south wind was cut down a few years ago. The south wind brings the fever. Manzania was lately almost free from malaria, which has, however, appeared since some shepherds set fire to a forest of olive trees on the south side. There has been a similar phenomenon at Sezze. At Supino, which was formerly a comparatively healthy place, the malaria has become acclimatized since the destruction of a wood stretching to the south, and many of the inhabitants have fallen victims to it. Lancisi relates that the unhealthiness of Rome has perceptibly increased since Pope Gregory XIII. unfortunately had a forest of pines in the south cut down, because it served as a retreat for brigands and murderers.

On the other hand, proofs are not wanting in support of the good effect of plantations. One of the most striking examples is the Abbey of Three Fountains near Rome, which a few years ago was one of the most unhealthy places in all the Roman Campagna; but has for the last two years enjoyed quite a different climate, owing to the eucalyptus plantations which have been formed there on a large scale. This tree seems particularly fitted for counteracting malaria, both on account of the extraordinary power of its roots in absorbing the moisture of the soil, and the smell of camphor which its leaves exhale. The utility of all plantations arises from the fact that the miasma is detained in the leaves, through which the air is in some sort filtered, while at the same time the oxygen disengaged from the foliage further contributes to the purification of the atmosphere. *Les Mondes, March* 23, 1876.

A Cure for Cold in the Head.—Dr. Ferrier, of King's College, in a letter to the "Lancet," communicates a remedy for cold in the head, which has been found effectual. It is a white powder used as snuff, and composed as follows:—

Hydrochlorate of morphia . .	2 grains.
Acacia powder	2 drachms.
Trisnitrate of bismuth . .	6 „

The whole makes up a quantity of powder, from a fourth to a half of which may be safely taken in twenty-four hours. Dr. Ferrier has twice cured himself of very severe colds by this means, once by the use of trisnitrate of bismuth alone, which is a very powerful remedy for catarrh of the mucous membrane, and is the most important ingredient in the above mixture. Others have used the snuff with perfect success. Instead of increasing the tendency to sneeze, it almost immediately begins to diminish it.

§ 5. *Fuel, Heating, Illumination, &c.*

Exportation of English Coal.—The exportation of English coal amounted in 1875 to 14,475,036 tons, without reckoning 3,278,247 tons carried away for the use of steamers. This is an increase of about 450,000 tons on the export of the previous year.

Photographic Polychrome.—M. Léon Vidal has discovered a method of reproducing in all their various colours the objects which photography represents in only one colour. Numerous remarkable specimens of the application of the process have been examined by competent authorities, and pronounced satisfactory. It is evident that if it can be brought into use, it may be the means of rendering valuable service to art by a more effective reproduction of masterpieces in painting and sculpture than has yet been accomplished.

Anthracite Coke.—Mr. Smith, near Swansea, makes anthracite coke with the following mixture: anthracite 60 per cent., bituminous coal 35 per cent., pitch 5 per cent. This coke is very brilliant, with fine grain and moderate density. It is remarkably clean. When used at the Landore steel works in two blast furnaces, one for hæmatite and the other for spiegeliron, turning out 300 tons a week, it was found that 18 cwt. of coke sufficed to treat 2 tons of 50 per cent. ore. To accomplish the same work about 27 cwt. of the best Glamorgan coke is required.

§ 6. *Miscellaneous.*

Chemical Separation of Animal and Vegetable Fibres.—Mr. James Stuart proposes the following method of chemically separating animal and vegetable fibres. In 110 gallons of warm water dissolve a hundredweight of sulphate of alumina, and add half-a-hundredweight of chloride of sodium or common salt, thus obtaining sulphate of soda and chloride of aluminium. With this solution saturate the material to be treated, and let it drip in order to get rid of the excess of the solution. It may also be wrung or slightly pressed. After this, dry it and spread it out under a temperature of 200° F.

While it is thus spread out the chloride of aluminium is decomposed, and the volatile products resulting from this decomposition act on the vegetable fibres, which are reduced to dust.

This treatment is especially suitable for rags and lighter tissues. When heavier fabrics are to be treated, the chloride of alumina should be more concentrated. In 110 gallons of water a hundredweight and a half of sulphate of alumina should then be dissolved, and three-quarters of a hundredweight of chloride of sodium, the rest of the process being the same as above.

In many cases it is found useful to boil the fabrics before spreading them out in the drying-rooms.

Mr. Stuart then proceeds thus: he prepares a solution of sulphate of alumina by dissolving a hundredweight of this substance in 110 gallons of water. With this solution he saturates the fabric, and then lets it drip. After this he puts it in a concentrated boiling solution of common salt. Lastly, he boils it till the vegetable fibres are decomposed, washes, and dries. *Moniteur de la Teinture.*

The Mercantile Fleet of Germany.—On the 1st of January, 1875, the merchant ships of Germany numbered 4,062, with a tonnage of 1,068,383, and 42,424 sailors. In 1874 there was an increase of 107 vessels, nearly all steamers. From 1870 to 1873 the number of sailing vessels continually decreased, and in 1874 it increased a little. Of the 4,062 vessels, 2,493 belong to ports on the North Sea, and 1,569 to the ports of the Baltic. *Revue Industrielle, March* 15, 1876.

Waterproof Textures.—M. PARONE, of Turin, proposes the following method of rendering textures waterproof. In 14 pints of water, heated to about 180° Fahr. dissolve 10½ lb. of gelatine and 21 lbs. of castor oil soap, then add 10½ lbs. of gum lac, shaking the liquid till the gum lac is completely dissolved. Take it off the fire, and add to the mixture in small quantities at a time 21 lbs. of powdered alum, shaking it till the alum is dissolved. The liquid thickens, forming an insoluble alumina soap which remains closely incorporated with the gelatine and the gum lac. It is spread over the textures with a brush. *Revue Industrielle, March* 22, 1876.

Cement for joining Metals with Non-Metallic Substances.—To obtain a cement suitable for joining metals and non-metallic substances, mix liquid glue with a sufficient quantity of wood-ashes to form a thick mass. The ashes should be added in small quantities to the glue while boiling, and constantly stirred. A sort of mastic is thus obtained, which, applied hot to the two surfaces that are to be joined, makes them adhere firmly together.

A similar substance may be prepared by dissolving in boiling water 2¼ lbs. of glue and 2 oz. of gum ammoniac, adding, in small quantities, about 2 oz. of sulphuric acid. *Revue Industrielle, March* 29, 1876.

To prevent the Cracking of Glue.—When articles that have been glued are exposed to great heat, they are often much damaged by the cracking of the glue. This evil may be avoided by adding to the glue chloride of lime, which is a very soluble salt, and prevents the glue from drying so as to become brittle. Glue so prepared adheres firmly to glass, metal, &c., and may be used for sticking on tickets so as not to come off. *Pharm. Zeitsch. of Russia.*

Skating all the Year round on real Ice.—The artificial manufacture of ice has made considerable progress of late years; but all preceding systems appear to be surpassed by that for which Mr. Murray has obtained the patent in France. The great difficulty of preceding inventors has been that of conveying the freezing current without risk of solidifying the liquid by means of which the cold is produced. A strong saline solution has often been tried with more or less success in principle, but practice has shown, not only that this solution corroded the conduit pipes, but it was very liable to freeze, and consequently burst the pipes. Another inconvenience of the use of salt is the escape of the saline fluid, which penetrates through weak places in the pipes, and, mixing with the ice, thaws it.

These defects are all avoided in the process of which Mr. Murray has the patent, and the secret of which consists in employing as freezing liquid a mixture of glycerine and water. Pure glycerine easily freezes, but mixed with water it resists the severest cold. It is possible, therefore, as experience proves, to communicate to this solution of glycerine an intense cold, and make it circulate incessantly through a system of pipes covered with water, which hence in a few hours becomes hard ice, transparent as crystal. The freezing liquid suffers no loss during its circulation, but may be used indefinitely, which is an economical feature in the invention.

Skating is now so fashionable, that it has been determined to afford the Parisian public an opportunity of enjoying the exercise all the year round. As ice will be manufactured at the same time by the same machine at eight shillings a ton, the expense of working the system will be reduced to a minimum, and large profits are anticipated. A large lake of ice, surrounded by restaurants, cafés, &c., fitted up with taste and all modern improvements, has just been opened in the neighbourhood of the Champs Elysées. *Les Mondes, April* 6, 1876.

The Mineral Wealth of Japan.—It appears from a report of Mr. Plunkett, the secretary to the British Embassy at Japan, that the mineral resources of that country have been over-estimated, and that, though it contains considerable deposits of ore, it is not likely to take a high place among the mineral regions of the earth. The total production in coal, copper, silver, gold, iron, lead, and tin for the year 1874 amounted to £752,818 sterling of which £398,125 was for coal.

No doubt, this insignificant result is owing partly to the imperfect mode of working the mines. In Japan adit levels are used with few exceptions, as the rude pumping apparatus do not admit of shafts. This circumstance explains the great number of abandoned mines. The total production in coal is estimated at 390,000 tons, of which 315,000 tons were obtained from Nagasaki.

Japanese copper is distinguished by its superior quality. It is free from arsenic and antimony, and on this account is said to be especially suitable for use in telegraphy. The copper ores yield as a rule between 2½ and 12 per cent. The total production in refined copper in 1874 was estimated at 3,000 tons from no less than 200 mines, which are worked in very primitive methods, the proprietors being indisposed to adopt improvements. Gold and silver occur in Japan in only small quantities. Rich iron ores are found in the province of Hitachi, where an English engineer is employed by the owners. In the province of Rikushiu, rich deposits of magnetic iron-stone are found. The government contemplates the erection of large iron works there, and expects great success. The most important lead mine is at Ani, near Lake Biwa.

Mr. Plunkett expresses regret that the Japanese government excludes foreigners from any share in mining enterprise, and considers that, without foreign capital and a mode of working corresponding to modern progress in science, no favourable result can be obtained. It is certainly surprising that, though Japan is now favourable to progress, laws still exist there according to which all foreigners are denied possession of shares in mines, and they are not even allowed to advance money for mining undertakings. As engineers and servants foreigners may be employed in mines, but if a foreigner wishes to make a contract which is to be binding by law, he must send to the government office a written declaration that he has no share in any mine.

The right of working a mine is granted to the owner of the soil only after having obtained special permission from the Mining Department of the government, usually for a period of fifteen years. For this privilege he has to pay a duty, the amount of which varies with the value of the mine. In the government offices there are at present twenty-three Europeans employed, a number far short of the requirements.

The cause of the Retreat of the Glaciers in the Alps.—The fact of the retreat of the Alpine glaciers is indisputable. The only question is, what is the cause of the phenomenon?

The period 1861—1874, compared with the preceding twenty years, shows at St. Bernard an increase in temperature of 1·65° Fahr., and a decrease in rain of eight inches, and, what is most remarkable, a reduction of more than half in fall of snow, 15¼ feet instead of 32¾ feet. For Geneva the fourteen years, compared with the preceding thirty-five years, give an excess in temperature of 1·15° Fahr., and 32¾ inches of rain. Consequently the cause of the retreat of the glaciers is evident. During the middle ages the glaciers of the Alps were less extensive than now, which seems to show a certain periodicity in the phenomenon. *Paper by M. L. Gruner in Comptes Rendus.*

The Lac Tree.—Lac is a varnish which can hardly be impaired, and possesses a transparent brightness. It is applied to every variety of useful and fancy articles. It is found abundantly in Japan and China, but the Japanese lac is far superior in quality to the Chinese. This product has long been much sought after by European countries, and it is the most important article of export. Wax is extracted from the fruit of the lac tree, and Japan derives large profits from traffic in this substance.

There are two lac trees, the male and the female. The male bears no fruit. It is not till the trees have reached the age of four or five years that any use is made of them. Produce is obtained from them for only three years, and after that they are cut down. The Japanese propagate the tree either by seed or cuttings. The former method produces seedlings of inferior quality.

For extracting the lac account is taken of the quality of the soil, the size of the tree, and its height. A horizontal gash is made in the bark with an implement called *kaki-gama*, a sort of

double hook, then an incision in the middle of the gash. Through this opening the lac flows, which is taken up with an iron knife and poured into a vessel fastened to the girdle of the collector, who makes incisions in one tree after another for four days. He then goes back to the first tree, makes a gash above the former one, and repeats the operation on each of the trees previously cut. The incisions are begun again in the same order from below upwards until the whole tree has been gashed, after which the tree is cut down.

The branches are cut off, made into a bundle, and put in water for ten or twenty days. If they are large, incisions are made in them with the *kaki-gama*. For small branches a small-bladed instrument is used, which cuts both ways. *Les Mondes, March* 23, 1876.

An Apparatus for registering Sound.—A scientific American has invented a curious apparatus, by means of which the various sounds of the human voice can be rendered visible. It consists of a tube closed at one end by a vibrating membrane, in the centre of which a mirror is fitted. If the mouth is applied to the other end of the tube, and sounds are uttered either in speaking or singing, the membrane and the mirror vibrate under the action of the sound-waves developed in the tube. If during this operation a ray of light falls obliquely on the mirror, and is reflected on a screen, a variety of curves will be formed visibly upon it, which are repeated with the same exactness as the sounds made in the tube. It would seem that, with the assistance of sensitive paper, the sounds might also be photographically registered.

The relation of Spots on the Sun to Storms.—It is certain that the sun plays the chief part in the meteorological phenomena of our planet. Though we cannot easily understand how its spots can influence our atmosphere; though, even when largest and most numerous, they cover a comparatively small part of its disc; though we do not know whether they are outbreaks of heat or tendencies to coolness, or whether they operate by way of heat or electricity, or in any other way, nevertheless appearances go on developing and multiplying effects which seem dependent on the periodicity of the spots.

M. BEZOLD, a philosopher of Munich, has recently devoted himself to a special study of the storm period, chiefly availing himself of the documents collected in Bavaria. The first fact which claims attention is that, if a certain period of years is examined, the number of storms goes on increasing or decreasing, but these variations are periodic.

If we inquire what are the meteorological causes that can be in relation with storms, the first that presents itself is heat. M. Bezold constructed a curve of the mean temperatures of each year, and compared it with that of the sun's spots. Afterwards he compared the two curves with that of the annual number of storms, and found that the minimum of storms exactly coincided with the maximum of solar spots. On the other hand, the curve of storms forms in some measure the middle term between that of the sun's spots and that of the deviations of temperature from the mean temperature of southern European latitudes.

It is observable that the course of storms shows a general and undoubted relation to that of the curve of solar spots, so that, *e.g.* from 1775 to 1822 the maxima of the first exactly corresponds with the minima of the second. Nevertheless, the details of the curve of storms agree better with those of the curve of temperature, and nearly every elevation or depression of the latter may be traced in the former. This relation between storms and the deviations of annual temperatures from the general mean temperature is manifest even when that between storms and the sun's spots is less evident.

The general result may be thus stated. High temperatures, as well as an absence of spots from the sun's disc, produce a greater number of storms during the year than the opposite of these conditions. On the other hand, supposing the maximum of solar spots coincides with the intensity of the aurora borealis, it follows that the two forms of electric phenomena are complementary, and that in the years in which there are many storms there are few auroræ boreales, and *vice versa*. It is not proved that this is the result of a direct electric influence between the sun and the earth, because these effects may depend upon the intensity of the heat which emanates from the sun. It would be well to have similar comparisons made in other latitudes. *La Gaceta Industrial, March* 10, 1876.

A Method of Transferring Drawings for Engraving on Copper or Steel.—M. G. WITZ, in a paper in the *Bulletin de la Société Industrielle de Rouen*, calls attention to the following method of transferring drawings for the purpose of engraving on metals.

The drawings—sometimes very large, like those intended for furniture—are traced on vegetable paper, all the outlines being followed with a colour formed of red mercurial iodide, which may be mixed with a little white lead, and a very small quantity of liquid gum. Camel-hair brushes or quill pens should be used instead of steel pens, which would be attacked by this kind of ink. It must not be forgotten that iodide of mercury is a violent poison.

When the strokes are dry and the tracing is quite finished, nothing more is required than to place the vegetable paper, stretched out, on the metallic surface—which must be previously cleaned and completely freed from grease—and cover the whole with other papers and weights to give a moderate pressure. The tracing is kept in its place with a little white wax on the vacant spaces of the paper. If a printing roller is used it is well to surround it with a strip of calico well calendered, of about a hand's breadth. Two persons should roll this strip in a spiral all round the roller, taking care to avoid folds, and stretching it well. The ends should be fastened with ribbons. After contact for a few hours or a night, the smallest details of the drawing are found definitely reproduced, and at first stand out dull on the shining surface. Then, the corrosive action still continuing a little, they appear after a few days' exposure to the air in strokes of a more or less deep grey colour, but very visible, completely resisting the rubbing of the fingers whether moist or dry, and remaining unaltered for the time required by the engraver. The intensity of the impressions may vary according to the temperature and duration of contact, as experience soon teaches.

If the vegetable paper used for the tracing is kept away from the light, fresh impressions, perfectly identical, may be obtained after several months.

The preparation of iodide of mercury is very simple, and the expense small, compared with the advantages obtained. The following are the proportions: Pour a solution of 40 grammes (25·6 dwts.) of bichloride of mercury or corrosive sublimate in half-a-litre (about three-quarters of a pint) of water into a solution of 50 grammes (32 dwts.) of iodide of potassium in the same quantity of water. The precipitate, 66 grammes (42 dwts.), is washed with cold water by decanting, drained, and dried under cover from the light.

Maritime Telegraphy.—It is stated that several maritime powers are considering a project for establishing telegraph stations in the open sea, so as to enable those on board sailing vessels and steamers to have communication with the main land. The invention would consist of a floating chamber fitted by a ball joint to a connecting cable descending to the bottom of the sea, and fastened to the principal submerged cable. The electric apparatus on board being brought into contact with the connecting cable, it would be possible for ships in danger to communicate with the nearest port, and at least make known their condition. *Technologiste, April* 15, 1876.

Sounding Telegraph.—At a recent sitting of the Manchester Scientific and Mechanical Society, Mr. BAILEY of Salford proposed the use of steam-whistles of suitable dimensions, and having sounds that might form an alphabet like that of the Morse telegraph, to take the place of visible signals which are not available in foggy weather.

To carry out this idea, large whistles have been constructed at Albion Works, Manchester, suitable for the purpose. It is well known that a whistle constructed to produce a sound with steam at high-pressure does not make any with steam at a low pressure, and *vice versâ*. To remedy this inconvenience, the tone has been rendered variable by means of a regulating screw. Moreover, to facilitate the opening of the valves, and render it possible with large diameters, and without strong pressure, use is made of two valves which balance each other. In this way a 12-in. whistle is opened with 100 lbs. of steam as easily as one of 2 in. with 30 lbs. of steam. In very dense fogs a 12-in. whistle is heard six miles off, and a 6 in. whistle three miles off. With the Morse alphabet twenty words a minute can be telegraphed.

Trades' Unions in America.—According to the "New York Times," the number of trades' unionists has fallen from 48,180 in 1873 to less than 18,000. This result is ascribed to the disastrous strike of 1872, followed by the commercial crisis of 1873. This concurrence of circumstances has shown the incapacity of the promoters of these associations to fulfil their promises, and what miseries the working men endure through rendering blind obedience to leaders not qualified to command.

The Silvering of Mirrors.—Down to the year 1840, the silvering of mirrors was performed by means of tin covered with mercury in a liquid bath. Such manipulation necessarily ex-

posed the workman to the pernicious influence of mercurial vapours, and many of them met with premature death after long sufferings.

In 1840 DRAYTON conceived the idea of covering mirrors with a thin pellicle of silver obtained by reducing an ammoniacal solution of nitrate of silver which moistened the mirror with essential oils easily oxidized. Pelitjian substituted tartaric acid for the various reducing agents previously employed.

The mercury bath, with its attendant evils, is now suppressed. Even in point of cost the use of silver is preferable. A mirror is silvered in a few hours, whereas the old tinning process lasted twelve days at least.

Still, silvered mirrors have a yellow tint not met with in tinned ones, which is a serious defect in practical use. Moreover, the adherence of the silver to the glass is not so perfect as might be wished. It often happens that the silver leaf of mirrors exposed to the direct action of the sun's rays comes off the glass here and there. Lastly, the silvering, though covered with a thick varnish, gets black in course of time under the influence of hydro-sulphuric emanations. The emanations which rise from the water-hold of ships in the equatorial regions turn the mirrors black that are stowed in them. These defects are more than compensated by the saving of expense and the prevention of the maladies caused by the use of mercury, but it was desirable that, if possible, they should be avoided, and M. Lenoir has succeeded in correcting them by a simple manipulation which is harmless to the workman.

The mirror, silvered by any process whatever, is first washed, then sprinkled with a diluted solution of cyanide of mercury and cyanide of potassium. The silver displaces part of the mercury and is dissolved. The rest of the silver gives rise to an amalgam whiter and more adherent to the glass than silver itself. This transformation is instantaneous. The proportion of mercury fixed does not exceed 5 to 6 per cent. The management of the cyanides, which are very poisonous substances, does not give rise to any danger when they are in very diluted solution. The daily practice of electro-platers, who have used them for more than thirty years in much more concentrated solution than M. Lenoir does, has not occasioned any serious inconvenience.

The amalgamated mirror is free from the yellow tint of pure silver. It is also less liable to attack from sulphuric vapours, and perfectly resists the action of the sun. In this latter respect it is far superior to the tinned mirrors, the tin of which is affected by the prolonged influence of light.

Such are the results of two years' trial. Mirrors sent to the colonies have sustained no injury from the voyage, which was so pernicious to other mirrors, or from the action of the sun. M. Lenoir's process is therefore a decided improvement on all previous ones.

The Siemens Process for the Manufacture of Glass.—The fusion of glass has hitherto been performed in large crucibles placed, usually to the number of four, in the same furnace.

These fire-proof earthen crucibles are difficult to make. They require a whole year to dry before they can be used, and on the average do not last a month. They have to be filled every day with material enough for a workman's day's work. The blowers are obliged to go to work early, beginning on Monday at two or three in the morning, and an hour later on other days.

On the Siemens system the fusion takes place in a large furnace-crucible built of fire-proof bricks, and capable of containing material enough for several days' work; and, care being taken to fill it with as much as has been used, it is never left empty. As the glass is always in a state of fusion, the workmen can take their regular hours of work and rest, which is a decided improvement on the former method.

The fusion of the glass is accomplished by a mixture of gas and air, and a very ingenious application of the Bunsen principle, which allows a great saving of combustible and the entire suppression of smoke.

Such a crucible may serve for fourteen months, and the vaulted covering for two years. The regularity of the hours of work gives both masters and men great advantages. *Moniteur Industriel Belge, April* 1, 1876.

A new Treaty-port in China.—Recent advices inform us of the opening of the new harbour of Kiungchow, on the island of Hainan. Kiungchow is the capital of this fertile island, which imports opium, English goods, raw cotton, salt fish, and other provisions. The most important article of export is sugar, with which are combined betel-nuts, cocoa-nuts, various oils, hides, rattans, and building-wood. If no special advantages for foreign commerce are to be expected from the opening of the above harbour, it is a subject of satisfaction that by this fresh acquisition, through English intervention, in China, a not inconsiderable portion of country is rendered accessible to friendly intercourse, and a further share of coast trade ensured to foreign vessels.

Universal Exhibition in Paris in 1878.—It is officially announced that a universal exhibition of agricultural and industrial productions will be opened in Paris, May 1st, 1878, and closed October 31st following. The productions of all nations will be admitted.

Commercial Geography.—The importance of commercial geography, including a knowledge of the natural productions of various countries and climates, is now generally recognized. The Société de Géographie Commerciale, in Paris, has rendered good service to French industry and trade, and proposes to carry on its useful operations by the establishment of a permanent exhibition of the commercial productions of foreign countries, including those articles which have important uses in industry, but are found in only small quantities. Specimens of these raw materials will be sent to those manufacturers who are disposed to try experiments with them and make known the results to the society. It can scarcely be doubted that the institution about to be established, after the model of our East India Museum but on a larger scale, will be attended with beneficial results for trade and industry.

At a recent sitting of the Turin Geographical Society, the president announced that it was intended to form a special department for the promotion of commercial geography, and spoke highly of the services rendered to French industry by the Société de Géographie Commerciale.

Japanese Wax.—The chief wax-producing tree of Japan is *Rhus succedanea*. The fruit of *Rhus vernicifera*, which also contains wax, is used in the north of the country, but it gives an inferior product to that of *Rhus succedanea*, which flourishes only in the south. There it is found abundantly, especially in the islands of Kiushiu and Sikok, and is grown on dykes, roads, and the borders of fields, as well as near houses.

It is like all the *rhus* tribe in growth, and especially resembles the lac tree, but differs from it in dividing very much into strong branches near the ground, so that the chief stem is scarcely distinguishable. It also appears as if the tree was propagated by sprouts from the root. Its height seldom exceeds 30 ft. This small height in comparison with the peculiarly wide-spreading summit is characteristic of the tree.

The time for the appearance of new leaves is the month of April, and for blossoming, June. The fruit is ripe in October. When gathered in clusters, it is dried in the sun, and, after being taken from the stalks, sold to the wax manufacturers, by whom it is beaten while dry. The process employed is the same as the Japanese use for removing the husks from rice. A wooden tilt hammer worked by hand falls into a funnel-shaped wooden sort of trough, containing the material to be worked upon. By this operation, continued for a long time, the husk and softer part of the fruit are reduced to powder, while the inner stone remains and is separated by a sieve. By draughts of air blowing while the powder falls slowly from a height, the lighter husk is separated from the heavier part which contains the wax, but usually the latter is collected and again worked. In the poor island of Sikok a small per-centage of an inferior sort of wax is obtained by also grinding the stones.

The sifted powder containing wax is exposed to the action of steam in hempen sacks laid on bamboo wicker-work, so that the steam from a cauldron underneath may pass through. The contents are then, together with the sacks, subjected to considerable pressure, and the wax that flows out is received in the forms in which it goes to market. The instruments of pressure are usually of the most primitive sort.

The further treatment of the wax is very simple. In special bleaching works the raw wax is melted, pressed through strong cotton sacks, and dropped into moving cold water, by which means it is obtained in crumpled thin flakes and small pieces, which are bleached in the sun. For this purpose the wax is laid in shallow baskets, 2½ ft. long and 1 ft. broad, which are placed in long rows, often by thousands, in the open air. Here the wax is repeatedly turned according to the intensity of the sun's heat, and sprinkled with water, and, if necessary, even a second time melted. The wax then assumes a perfectly white colour.

The total export of wax from Japan for the year 1874 amounted to 1128 tons. The chief markets for this product are Nagasaki, Kobe (Hiogo), and Osaka. It is sent chiefly to China and London. *Oesterreichische Monatsscrift für den Orient, April* 15, 1876.

STEAM DOMES ON BOILERS.

MR. THOMAS HOGE, of Waynesburgh, United States, in writing to the "Scientific American," states that, after many years' experience with boilers of all kinds, he is unable to find any practical appreciable advantage in the use of steam domes.

"Small-necked cast-iron domes, so much used on portable boilers," he states, "are of no use so far as dryness of steam is concerned, even admitting that large-bottomed ones are; and domes are generally placed in about the worst place on the boiler to secure dry steam. Steam should always be taken from the back end of the boiler, or at the furthest possible place from where the most of the steam is generated.

"My experience and reading have led me to have less faith in the steam generating power of flues and to have more in that of the fire-box or of the two or three rings of boiler immediately over the fire, in stationary boilers. The greatest amount of ebullition taking place from the fire-box, there evidently will be the greatest amount of foam, spray, or water in other form, carried up with the steam, its upward current there being greatest; and the dome being set right over this point water goes directly into it with the current of steam; and if the neck or entrance to the dome is small (making in effect only a large swell in the steam pipe) the current of steam will there (in the neck) be so strong that no particle of water can ever descend through it while steam is being rapidly used, the only time when priming occurs. I believe that, usually, three fourths of the steam made in a boiler is made in the first third or half of the boiler. If, instead of drawing it off here, it were allowed to pass slowly back to the back end, and there enter the steam pipe, we should, in effect, convert nearly all the steam space along the top of the boiler into a steam dome."

"OVER-WINDING AND ITS PREVENTION."

IT has been properly observed that the ever recurring tales of slaughter, amputations, lacerations, contusions, and other more serious maimings in places of industry, read like the account of some past fierce and sanguinary contest on a field of battle, so forming a grim satire on the proverbial gentle arts of peace. The details of these sad mishaps may be found in the government returns, and although it is true that by far the greater portion of these accidents is due to the carelessness of the employed or of the victims themselves, still it is also an indisputable fact that in many instances the employers are much to blame for such distressing occurrences. Confining our attention for the present to the "Mining Industries," we will not assert that the hazardous undertaking of the underground worker can be now actually converted into a perfectly harmless occupation, for all the laws of nature are not yet written in the book of science; some are well known, but of others we possess but a vague notion, and probably we have not the faintest idea of the remainder. No doubt science is daily contributing to the possible reduction of such disastrous occurrences, consequently those cases in which "absolute ignorance" may be used as an excusable plea are gradually becoming rarer and rarer. In spite of the jeopardized life which the miner leads, be it either through his exposure to explosions of fire-damp, the falling in of sides or roofs, breakage of ropes or chains whilst ascending or descending, falling into the shaft, or things falling down the shaft, explosions of gunpowder, suffocation by gases, falling into water, irruptions of water, collision with trams and tubs, or from machinery underground or on surface, lastly from over-winding, we have reason to believe, that with time and a better training-up system of the working community, all these sources of danger to life and limb will be rendered potential and safety actual, inasmuch as the present dangerous state will be converted into a "safe and sure system" by the operation of scientific thought and the application of scientific skill.

If we accept, as all scientific men admit, that there is "no effect without a cause," then once knowing the cause it becomes an easy matter to counteract it, and so prevent the effect. It is true that the cause of many disastrous colliery accidents, such as the irruption of water, explosions of fire-damp, gunpowder, or of gases, &c., is very frequently too obscured or concealed to become always apparent. However, such is not the case with the class of accidents with which we wish to deal in the present article, and consequently their prevention appears at first sight easy to accomplish. The problem is, however, fraught with many difficulties, as we will presently show, when we allude to the prevention of over-winding accidents.

Over-winding is the term given to such accidents as are caused by the shaft-cage being raised too high above the pit-bank, and often result in the cage being drawn over the head-gear pulley, carrying destruction and possibly death in its course. The truth of this latter assertion is unfortunately too well founded, for government returns now before us prove that during thirteen consecutive years, the whole number of persons who suffered from over-winding accidents, died from the effects thereof; the seriousness of such mishaps is thus ascertained beyond all doubt. Considering the many improvements which have been and are continually being made in machinery for winding purposes, and notwithstanding the powerful brakes and apparatuses which are now so easily placed within reach of the engine-driver for instantaneously stopping the drum, it may appear a mystery to many that over-winding can and does occur. However, in reality the mystery is not that such accidents actually do take place, but that they are not of more frequent occurrence. To prove this latter assertion, we append the following tabulated facts[1] concerning the winding arrangements of some of our collieries:

Colliery.	Weight of Cage.	Mean speed of Cage in Shaft.	Maximum speed of Cage in Shaft.	Depth of Pit.	Time occupied each Journey.	Time occupied in Landing.
	Cwt.	Feet per min.	Feet. per min.	Feet.	Sec.	Sec.
Harton Colliery . .	50	1,020	...	1,278	75	30
Monkwearmouth . .	35	1,180	1,630	1,740	89	35
Usworth	22½	1,300	1,706	966	45	...
Denaby	48	1,691	3,080	1,351	47	21
Boldon	40	1,689	2,788	1,545	55	...
Douglas Bank . . .	20	1,765	3,100	1,530	52	25
Rosebridge	22	2,590	5,100	2,418	56	25
Houghton-le-Spring .	18	1,302	2,436	738	34	25
Cinderhill, No. 1 . .	25½	1,320	...	666	30	30
Hucknall, No. 2 . .	30	1,652	...	1,239	45	25
Kiveton Park . . .	20	1,624	...	1,218	45	15

From this table we find the greatest maximum speed of the cage in the shaft to be that attained in the Rosebridge colliery, which is put down at 5,100 feet per minute, *i.e.* equivalent to a little over 50 miles an hour; a speed which almost comes up to the fastest trains of the Great Northern Railway. The average of the maximum speeds given in the table gives a speed of 47·4 feet per second, or 28½ miles per hour, which is considered a safe-working speed. If we, moreover, add to these data that the average time occupied in landing, as given by the fore-mentioned table, is but 26″, being in one instance as low as 15″, or again that in a double shift of twenty-four hours, the average number of single cage up and down journeys (computed from the nine fully specified collieries in the table) is represented by 516, which average number would require the winding-engine to be stopped and started 2,064 times in the said twenty-four hours, or eighty-six times to the hour, *i.e.* once regulated every 41·9″, we perceive from the table, that though this amount of duty expected from the engineer is in itself enormous, it is by far exceeded in several of the collieries enumerated in the table;[2] thus at the Kiveton Park and Cinderhill No. 1 collieries the engines are regulated on a day's average once every 30″.

From the fore-mentioned deductions, we perceive the difficulty or rather uncertainty of being always able to stop the winding arrangement, going at the speed of 28 to 50 miles an hour, at the shortest notice; and we likewise note the great strain which is put on an engine-tenter's ability to keep his machine in regular working order, for the slightest error of judgment, a moment's inattention, or the least possible neglect on his part, and the result may be the ruin of property, and simultaneously loss of life or limb.

The causes of over-winding were very appropriately classed under the two headings of human and mechanical deficiencies, in a paper recently read[3] by Mr. Wright, before the Derbyshire Institute of Engineers. Under the first classing we find deficiency of training, carelessness, drunkenness, weariness, distraction of attention by people entering the engine-room at a

[1] Extracted from *Colliery Guardian*, June 25, 1875.
[2] Provided the table be correct.
[3] July 8, 1875.

critical moment, innocent mistakes, sudden fits, or even death itself; whilst defective construction of machinery and brakes, &c., may be taken as mechanical sources of over-winding. We cannot suppress our conviction that in all pit-windings, where no attempt to prevent over-winding is made, the engine-tenters have far too much left to their own proper care and judgment, for we need only remind the reader that numbers of innocent persons continue yearly to sacrifice their lives, partly to the imprudence and partly to the negligence of the tenters, thus presenting abundant evidence to prove the necessity of providing every pit arrangement with mountings, which in case of danger will prevent or remedy the mishap, and become their own tell-

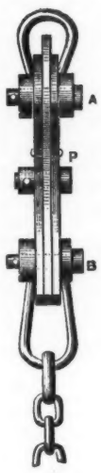


Fig. 1.

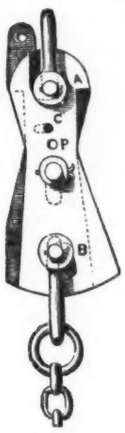


Fig. 2.

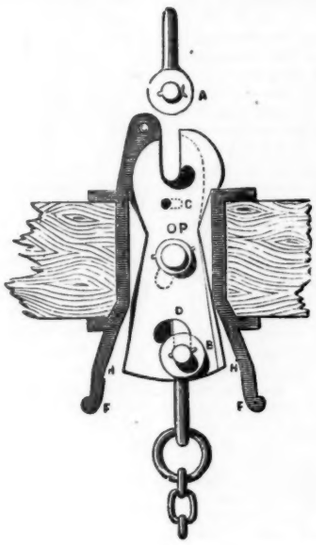


Fig. 3.

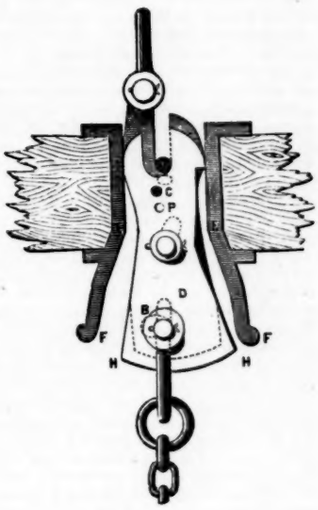


Fig. 4.

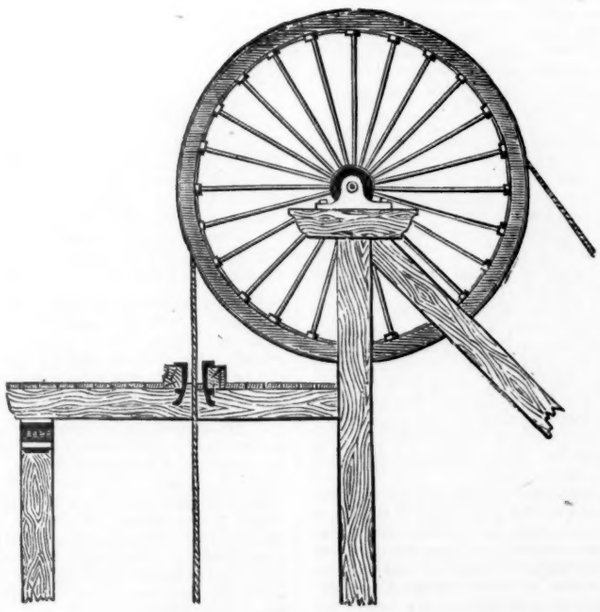


Fig. 5.

tale. This the more so, for however careful and intelligent the men may be to whose care winding-engines are entrusted, it is neither prudent nor safe to rely solely on their attention where so much is at stake.

Having thus demonstrated the objectionable nature of the common winding arrangement, we may reasonably hope that the many suggestions which have been submitted from time to time to the respective head-quarters, may be speedily put into the form of practical law. The importance of the problem has naturally brought out many plans with the object of grasping the most intelligent, thorough, and expeditious means of checking the consequences of over-winding accidents, and that being the case, the only point now to be settled is, according to our opinion, how best we are to carry the purpose into effect. No doubt we shall be best guided in the solution of the problem now proposed, by drawing upon and utilizing our past experience. Although we shall have to follow to a certain extent the tendency of the age which is to pay for results, we think that the mode of accomplishing the object in view need not be necessarily attended with a heavy outlay, which fact speaks

highly in favour of a radical change on the old winding system, as it in no wise impairs the adequacy or efficacy of the proposed improvement, but reduces the validity of those arguments which might be advanced on grounds of a heavy prime cost.

The principle which is involved in the true solution of the problem is the exact stoppage of the cage at the pit's-bank or bottom. If the steam be shut off at the right time the engine will cease to work when the up-cage has reached the bank, and consequently the up-corf will then also come to a stand-still at the time required. The exact letting on and off of the steam to the engine is of course the tenter's work, and the exactitude which is acquired by this class of men through long practice is certainly remarkable in many cases, though if on the other hand the engine-tenter allow the steam to be too long admitted to the engine, over-winding ensues, and probably a disastrous consequence likewise follows his inadvertence. Two mechanical means suggest themselves for the proper shutting off of the steam to the engine. The first of these might be so fitted up towards the top of the shaft that a protruding rod from the cage, working in a protected grove cut in the shaft side, should strike on nearing the bank against a lever-rod arrangement placed also in the fore-mentioned groove, so giving motion to the latter, and through being in communication with the engine steam-valve, cause the steam to be cut off the moment the cage had arrived at the proper distance for so doing. Provided the lever arrangement was so constructed that the descent of the cage did not affect it, the work of the engine-man would thus be confined to answering the pit bell in starting the engine, by which means the really dangerous portion of his work would be done mechanically, as the ascending cages would alternately shut the steam off the engine. To ensure the correct working of the lever arrangement a bell alarm might be attached, which should work in case the fore-mentioned lever arrangement happened to get out of order or break. Another way of accomplishing the proper shutting off of steam to the engine suggests itself in connecting the engine with an engine-counter, which on a fixed number of revolutions being made by the drum-shaft, should work a lever-rod, likewise closing off the steam from the steam cylinders, and thus reducing the engine-tenter's work by one half. Although this latter suggestion has the advantage of being less expensive in its application, and is also within easy reach of the engine-tenter, no doubt practical objections present themselves to the satisfactory working of each of these plans. Thus, with the first mentioned plan, varying cage loads would require the lever arrangement to be placed higher or lower in the shaft groove, and the distance of the engine-house from the shaft would likewise necessitate longer or shorter rod connections which are certainly objectionable in themselves; the wearing of the ropes would likewise act detrimentally on the second plan suggested, and necessitate, perhaps, frequent setting of the engine-counter, a disadvantage which would certainly be trifling, provided absolute safety from over-winding accidents ensued.

Even if the fore-mentioned suggestions show ways and means for the prevention of over-winding accidents, still were every engine-man as perfect at his work as human nature could be, yet such appliances would relieve the engine-man of much responsibility, and if we add to this that even in the hands of the most careful man a pure accident may occur at a critical moment, we think there is proper reason for the general attempts which have been introduced for avoiding accidents in actual cases of over-winding. The working action of the most successful of these apparatuses, seems to follow the rule, that in a case of over-winding, at whatsoever speed, as soon as these apparatuses arrive at a spot below the head-gear pulley they catch, locking themselves with the cage suspended firmly in the head-gear, and at the same time releasing the winding rope.

Our figures 1, 2, 3, 4, and 5, represent one of these apparatuses known as Ormerod's Safety Link for the prevention of accidents from over-winding. Fig. 1 is a side view, fig. 2 a cross view of the link, whilst fig. 3 represents the position it assumes when wound up, the rope shackle being disconnected and the link locked in its position; fig. 4 shows the rope shackle recommenced for lowering the link, and fig. 5 gives us a section of the head-gear arrangement. The apparatus is thus described by the inventor: This link is wider at the bottom than at the top when in ordinary use as in fig. 2; but in the event of over-winding, the link is drawn into the bell-mouthed cylinder EE in fig. 3, the wide part of the link at HH coming in contact with the cylinder at FF thereby closing the bottom part of the link and causing the top part to expand, and the projections to catch over the top of the cylinder, while at the same time the rope shackle is forced out of its seat and allowed to go free, and the bottom shackle B drops into the slot D and locks the link firmly in its position. The cage being suspended from the chain cannot fall back. To prevent the possibility of the link becoming disarranged in ordinary work, a small pin P is inserted through the plates, which pin is sheared off as the apparatus passes into the cylinder. For lowering the cage the shackle is attached to the ear on the middle plate, as shown in fig. 4. On removing the pin C, and slightly winding the rope, the middle plate having a slotted hole in, the pin is elevated into the position shown and allows the apparatus to pass down through the cylinder and safely lower the cage. A platform is provided on the head-gear, as shown in fig. 5, for the convenience of the man attaching the rope.

In the apparatus before us the weight of the load has no tendency to cause the pin of the rope shackle to move out of its seat in the jaw, and means are also adopted to prevent falling pieces of coal, &c. when striking against the projecting feathers, bringing it into action at the wrong time.

With regard to this latter class of appliances, it must certainly be conceded that they are a great improvement and a safety factor in winding arrangements; it cannot, however, be said that they absolutely prevent over-winding, although they prevent the cage from being drawn over the head-gear pulley. There are hundreds of cases in which they have done valuable service, and saved both life and property. In the majority of cases the cage remains stationary; but it has likewise occurred that even when these safety links were attached, the cages when in full swing have struck heavily against the head-gear and sustained damage. This might be remedied by allowing the cage-chains to be sufficiently long to prevent the rebound of the cage, caused by sudden stoppage, reaching the head-gear. They require a very strong head-gear to resist the shocks, caused by the link entering possibly at full speed, but in no wise relieve the engine-man of responsibility since they become their own tell-tales in cases of full over-winding, and they equally well answer their purpose should the winding engine be started the wrong way.[1]

Engineering, Building, &c.

ABSTRACTS FROM FOREIGN PERIODICALS,

TRANSACTIONS OF SOCIETIES, ETC.

§ 1. *Engineering.*

COMBINATION of Iron and Steel.—Mr. WHEELER, an American engineer, is said to have succeeded in making iron cannon with an inner coating of steel. This important invention, which may bring about a revolution in the manufacture of cannon, is to be tested by a series of experiments under the superintendence of a Government Commission. Mr. Wheeler hopes to apply it to the manufacture of rails for railways also, thus giving them the hardness and flexibility necessary to avoid the present amount of wear.

Glass Axle-bearings.—At Pittsburgh glass axle-bearings are made, which are recommended on account of their cheapness and slowness in heating. They also require very little grease. One of these axle-bearings sustained a pressure of more than 1,000 lbs. to the square inch before it broke. Some of them have been put on wagons and trucks with satisfactory results.

Anti-dry-Rot.—Messrs. VILAIN and Co., of Berlin, manufacture, under the name of mycothanaton, a product which has the property of destroying dry rot in houses and other buildings, and preventing its appearance in new ones. It may also be employed with advantage in seasoning railway sleepers, telegraph posts, beams, &c., which it effectually preserves from decay. It is a clear liquid, containing no poisonous or disagreeably smelling substance. Its presence in the atmosphere is good for the health, as it destroys miasma and ferment. Lastly, wood impregnated with it does not easily catch fire, which has been repeatedly proved.

It requires boiling in a cast-iron boiler, and in this state is to be spread over the surfaces covered with dry-rot, by means of a large brush. During the boiling the boiler must be kept carefully closed. Wood which is to be impregnated with it must be first cleaned.

The efflorescence of masonry may be prevented by smearing the walls with this liquid. In old buildings the efflorescence should be first scraped, and after a layer of the liquid has been put on, the walls can be restored.

[1] Such a case happened to our knowledge some years back at the Birchwood Collieries, when one of King's safety links effectually prevented any accident.

New Protecting Envelope for Telegraph Cables.—The cable which connects Australia with New Zealand, and was laid by the Telegraph Construction Company, is not protected, like ordinary cables, by an envelope of iron wires covered with hemp, but by a covering formed alternately of a wire and a skein of hemp. The cost is much less than usual. Experience will show whether it will last as long as other cables.

Tramway Locomotives in Paris.—A locomotive without furnace has commenced running in Paris on one of the tramways. It has a reservoir of superheated water, which furnishes a constant supply of saturated steam for moving the vehicle. The advantages of this mode of traction are unquestionable. According to the accounts of correspondents there is neither smoke nor dead weight of combustible, nor complicated apparatus for making steam, and, lastly, little or no noise from the motion.

On another line of tramway an ordinary steam locomotive is at work. It is like a small omnibus in shape and size, containing a boiler. The furnace is out of sight, and fed with coke and charcoal. Consequently there is no smoke. The draught of the furnace is kept up by a supply of compressed air. The Parisians consider this one of the most elegant locomotives, and are eager to patronize it. *Moniteur Industriel Belge, March* 20, 1876.

The Conveyance of Dynamite.—In consequence of the general alarm excited by the Bremerhaven explosion, the Austrian government commissioned Dr. Beckerheim, Captain of the artillery staff and Professor of chemistry, to study the conveyance of dynamite, with a view to ascertain whether it is really dangerous.

After having made many experiments, Captain Beckerheim has come to the conclusion that dynamite by itself is safer for conveyance than any other explosive substance, that it is perfectly impossible for it to take fire when it is once packed in wooden boxes, and that if any accident happens, it must arise from negligence.

The Austro-Hungarian railways have up to the present time conveyed some twelve thousand tons of dynamite without the slightest accident, and the two establishments at Zamky and Presburg, not to mention many others, have sent five million tons both to the interior of the empire and abroad without having to regret any loss or injury. In America and in Sweden, where dynamite is continually employed in the mines, it has been found not only cheaper, but also safer than gunpowder. *Moniteur Industriel Belge, April* 10, 1876.

Iron Railway Trucks.—At the commencement of railways wood was almost invariably employed for making the frame and body of trucks. The wood ought to be of good quality, but in spite of strict examination, it was soon found that various defects appeared after short service, and that painting, though often repeated, did not protect it from the injuries caused by the air and weather. The trucks were without coupling and buffers, and, though wood is elastic, the various movements at stations soon put the framework out of order, and rendered frequent repairs necessary. To avoid these evils, the trucks were protected by buffers and springs. To prevent the frame pieces from bending they were covered with strong iron plates, and at last wooden frame-pieces were altogether superseded by sheet-iron plates from two-fifths to three-fifths of an inch thick.

Owing to the progress in metallurgy, which permitted a reduction in the price of iron, the plates have given way to iron frame-pieces having more rigidity and being more suitable in every way. Gradually the pieces of wood forming the framework have been replaced by iron ones.

Iron trucks last much longer than wooden ones, cost much less to keep in repair, and when they are worn out, the materials are worth far more than those of wooden ones. On various Belgian lines, where iron trucks are almost exclusively used, especially for the carriage of coal, the yearly cost of repair is £3. The length of time they last cannot be determined with certainty for want of documents, the first having been brought into use about fifteen years ago. There is, however, a truck on a Belgian line made entirely of iron thirty years ago, which is still in perfect condition.

In Germany, where the use of iron trucks for the conveyance of goods is general, it is considered that since they have been employed, the expenses of renewal and repairing have been less, the security greater, and the trucks have less frequently gone off the line because the parallelism of the axles remains invariable.

The use of iron frames has extended in Belgium to passenger-carriages. These rigid frames not getting out of shape like wooden ones, ensure a longer duration for the body of the carriage, and afford a great security in case of accident and getting off the line. It has been observed that iron frames resist the most violent shocks without fracture, and in such circumstances the body, which is fastened to it by nothing more than a few bolts, separates, is thrown on one side, and travellers are preserved even in the most dreadful accidents. In such cases a wooden frame is broken, and at the same time breaks the body which is united with it. Hence several are crushed together, and fatal results ensue. In this country, where the frames of carriages are still made of wood, railway accidents are more disastrous than in Germany and Belgium. *Moniteur Industriel Belge, March* 20, 1876.

A Cheap Strap.—The New York Belting and Machinery Company lately supplied the Chicago Elevator Company with a strap formed of sixteen layers of sail-cloth and caoutchouc. It was 4 ft. broad and 9 yds. long, and weighed 4 lbs. It works as easily as an ordinary strap, and does not make the least noise. If it had been made of leather it would have cost twice as much.

New Anti-Incrustation Substance.—A substance adapted to prevent incrustation may be prepared by diluting 16 parts of potato starch in 76 parts of water, then adding 8 parts of soda lye at 25° Baumé, and mixing the whole by stirring well. After a short time the mixture becomes a pasty mass, which, on being kneaded, becomes colourless and transparent, and of a slightly alkaline taste. On being exposed to the air, this substance dries slowly while decomposing. When it is completely dry, it has the consistence of horn, but is more supple. A small quantity of it placed in a boiler is said to prevent all incrustation.

It may be employed for all the purposes of gelatine. It is especially adapted for the sizing of textile fabrics, to which it gives a mellowness not otherwise attainable. When spread over stuffs and silks it becomes quite insoluble, even in boiling water. It may, therefore, well serve for thickening calicoes. It must be kept from the air to prevent it from hardening, for when once dry, it is almost impossible to dissolve it again. *Revue Industrielle, April* 19, 1876.

§ 2. *Building, Decoration, &c.*

To Protect Wood from the Action of the Air.—Wood will be effectually preserved from the action of the air if it is covered by a paint-brush with a solution of persulphate of iron, marking 2° to 2½° Baumé. The blue tint which is developed by drying changes to brown when a coat of linseed oil is laid on. *Revue Industrielle, April* 19, 1876.

Movable Scaffolds.—Scaffolds moving on wheels, and easily put up and taken down, are useful for the repair and cleaning of the interior of large buildings, such as the naves of churches or temples and large vestibules or passages. For such purposes they are far superior to the expensive, inconvenient, and often dangerous scaffolds usually employed. M. BOMBLIN'S movable scaffold on wheels is about 10 ft. broad and 11½ ft. long. There is a platform for the workmen at the top, which can be raised by means of slides to a height of 31 ft., and enables the workmen to reach a height of 37 ft. Steps placed on one of the slides admit the erection of a movable balcony 11½ ft. long and 2¾ ft. broad, which can be raised from 7¾ ft. to 15½ ft., so that the workmen can reach 21 ft. The chief advantages of the apparatus are, that it can be easily moved about, put up and taken down, and used for painting and repairing, not only the ceilings and roofs of high buildings, but also, by means of the movable balcony, the surfaces of walls. It may also be used by artists for painting frescoes and large paintings. It allows the artist to retire 17 to 19 ft. to judge of the effect of his work. *Bulletin de la Société d'Encouragement pour l'Industrie Nationale.*

Coating Masonry with Iron.—When they began to use raw iron in America as an outer coating for masonry, it was alleged that the dilatation and contraction would cause a disturbance of the joints, and consequently the speedy destruction of the walls; but experience has since contradicted this. Buildings of this sort, exposed for years to all the inclemency of the atmosphere, are still in very good condition. Docks, filled with very combustible materials, having been set on fire, have perfectly resisted the flames; only the interior masonry has been injured in these cases.

Iron coatings can be conveyed and put on, or taken off, at all seasons with great facility. They take up less room than ordinary materials, and leave more space free for buildings. When the buildings are pulled down, the plates can be taken off and used again.

Raw iron does not rust much in the air, so that there is no fear of damage from that source. A coating of paint from time to time effectually preserves it from rust. It is probable that, as it gets more known by experience, it will replace more expensive materials, such as granite and marble, in many cases.

DUPLEX PUMPING ENGINE.

AT a recent trial of one of Dean's duplex pumping engines, such as represented on the opposite page, at Charleston, Ill., four streams were thrown through 1-in. nozzles from hose attached directly to the hydrants. These streams were thrown to a height of 100 ft. This trial took place at the Court House Square, which is two and a half miles from the water-works where the pumps are placed, and 110 ft. above the level of the river where the pumps take water. The main at one point ascends to 130 ft. above the level of the pumps. The pumps represented have steam cylinders 16 in. diameter, water cylinders 10 in. in diameter, and a stroke of 16 in. The machine is capable, we are informed, of delivering 1,000,000 gallons in 24 hours; or when connections are made with hose to different hydrants, it will throw four 1¼-in. streams to a height of 130 ft. which is sufficient for towns with from 5,000 to 8,000 inhabitants. The manufacturers construct much larger engines of the same description, capable of delivering 6,000,000 gallons in 24 hours, or throwing twelve fire streams from the mains, all working equally well in connection with the reservoir, the stand-pipe, or the direct pressure system of supply. Steam is used expansively, and the larger engines are provided with adjustable cut-offs. The crank shafts are connected together by a coupling, and the cranks are set at right angles to each other, so that they may run very slow without stopping, or may maintain a high speed without injury. All bearings have large areas, and have means of adjustment in case of wear; the water cylinders are lined with copper; the valve seats are made of gun metal with noiseless rubber valves, and the larger sizes of pumps have hand-holes for examining or removing the valves. The piston-rods are of steel, and the water piston-rods are covered with brass. The crank shafts are made of hammered iron, the crank pins of steel, and the cranks of cold blast charcoal iron. Every part is made of the best material, and carefully fitted. All the pipes are carried under the floor, as shown. The steam supply-pipe is carried into the bottom of the steam chest, and the exhaust-pipe leads down between the pumps. The suction-pipe, which is brought up between the water cylinders, has a vacuum chamber attached, which is represented between the wheels.

All the pipes being out of sight gives the engine-room a very neat appearance and ensures a dry floor. In front of the steam cylinders are three throttle valve stands; the centre one is for running the pumps duplex, the others are for running them separately.

An important feature of this duplex pump is that it may be converted into two single pumps by uncoupling the crank shaft, which can be done very quickly. By closing the valve on one pump, the other may be run alone. This is a point of considerable advantage, especially where direct pressure is used, as the supply would be interrupted if the engine were stopped for a few minutes, and a fire might occur at the very time the engine is at rest.

We learn that this machinery has been in constant operation at Union City, Ind., night and day, for over two years, without stopping, and has never cost a dollar for repairs. The supply is there kept up by pumping directly into the mains, and in case of fire the hose is attached to the hydrants.

The following cities are also using the duplex pumping-engines, which furnish the entire supply of water for fire and domestic purposes: Peoria, Ill.; Alton, Ill.; Charleston, Ill.; Brazil, Ind.; Attica, Ind. It is claimed that the engines in Peoria are showing a saving of 35 per cent. in fuel over the machines previously used. And in all the other cities the machines are working with great economy, no fire-engines being employed, the hose being attached directly to the hydrants.

Water-works costing $100,000 have recently been erected at Alton, Ill. The Alton "Daily Telegraph," in speaking of the formal test and inauguration of the enterprise, says:—

"The work of construction began on August 15th at the tunnel and engine-house on the river bank. The work of laying the pipe in the water mains on the streets was commenced Monday, Sept. 6th, and continued without interruption till November 1st, when eight miles of the water mains had been laid. By Nov. 4th the water-works bonds for $50,000 had all been expended by Watson and Taylor. Eighty fire hydrants for the use of the city, according to the contract, were erected in various portions of the city, which work was completed Nov. 25th. On Dec. 5th the pumping machinery began to arrive, and was soon after placed in the works erected for this purpose. The first water thrown was on Jan. 7th, 1876, the entire work having been consummated in a little over four months. A high-service reservoir had been erected on State Street Hill, a height of 236 ft. above high-water mark of 1858, and 250 ft. above the pumps, capable of containing about 100,000 gallons. At this same location a large reservoir is yet to be constructed, with a capacity for holding 6,000,000 gallons.

"The system adopted is that of direct pressure, with storage reservoir, the engines and pumping machinery, except the steam boilers, being furnished by Dean Brothers, of Indianapolis. The engines are duplex crank and fly-wheel engines, which cut off the steam at three-fourths of the stroke, thus working expansively, economically, and noiselessly. The motive power and pumps are combined in one machine, and are known under the name of 'Dean's steam pumps,' which can be operated jointly or one at a time, as may be found necessary. The steam cylinders are twenty-four, and those for pumping 12 in. in diameter. Their combined capacity is claimed to be 5,000,000 gallons every twenty-four hours, and of exerting a pressure of 300 lbs. to the square inch. The peculiar feature about them is their great simplicity, and on first sight they appear very insignificant in size as compared with great power; but their superior capacity becomes apparent upon closer examination of their strong combination and compact proportions. The two steam boilers connected with the machines are 48 in. in diameter, 20 ft. in length, and contain each twelve 6-in. tubes. They can also be used jointly or singly, as desired, and their combined capacity is 200 horse-power. This machinery, with all necessary appurtenances, was built, delivered on the ground, and set up ready for work, by the Messrs. Dean Brothers, at the price of $6,500. During a trial of these engines they worked quietly and easily under a pressure from 60 lbs. to 70 lbs. of steam, and a pressure of water of 160 lbs. to the square inch, which could have been much increased if desired."—*The Technologist.*

THE VALUE OF WASTE.

WE much question whether any of the many forms of educational help supplied by the committee and council at South Kensington equal in importance and interest the wonderful collection, illustrating the utilization of waste products, now on view at Bethnal Green.

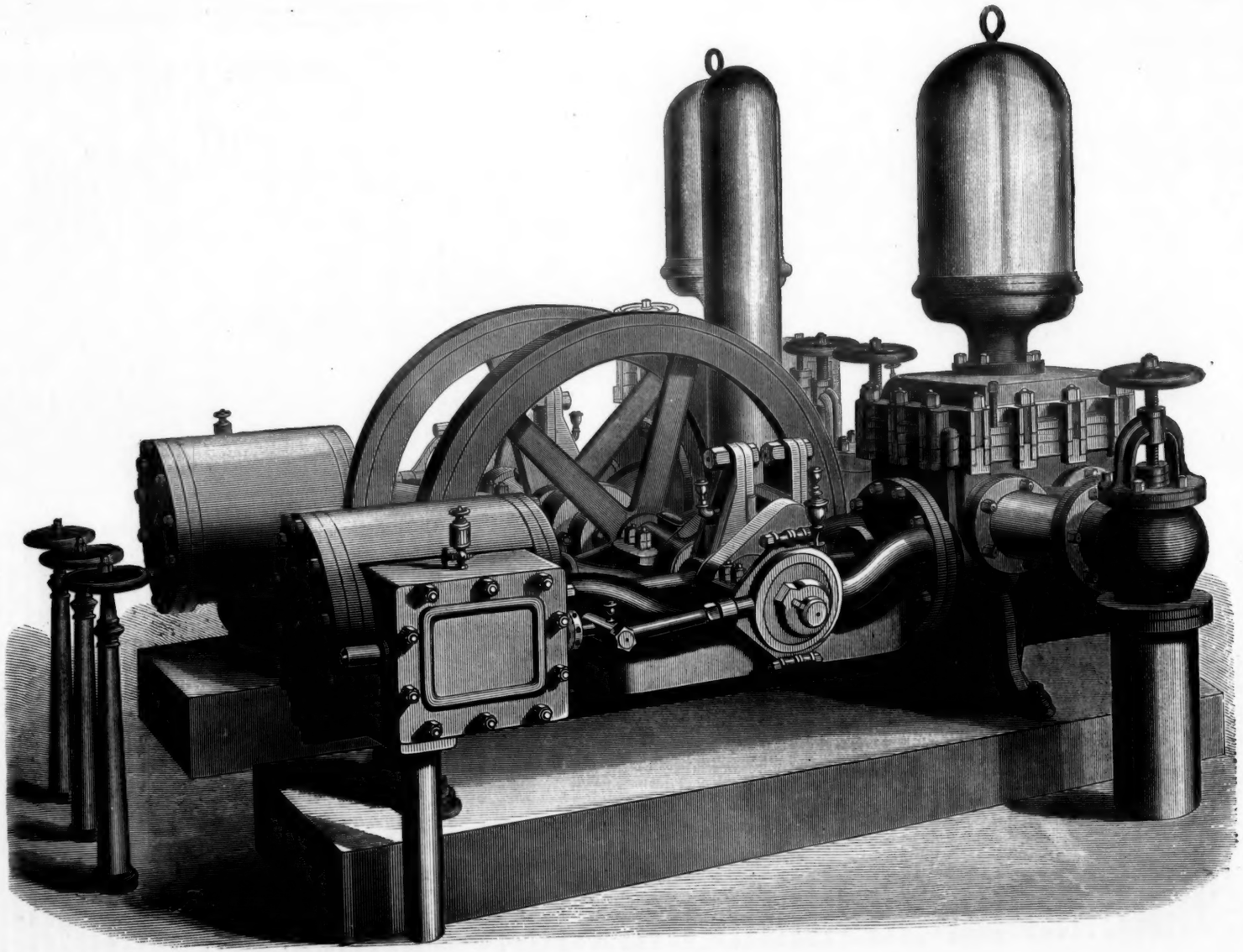
How we have come to designate any material waste is a mystery; it is unreasonable, for all matter is waste in one sense, and yet there is not an atom in the universe but has its uses, and therefore there can be no such thing as waste. Our prodigality in the treatment of matter is undergoing a very sharp and necessary correction, and the descriptive catalogue we now notice is one of the best methods to that end, because it classifies the thousand-and-one items, and explains the direct service they can render when wisely applied.

Waste is the name we give to the material rejected in the work of construction or manufacture; but such rejected portions are the material best adapted for other purposes, and when so applied are no longer waste. Torn, soiled, or printed paper is useless for its original application, but for conversion it is of the highest value. Woollen rags, that formerly were spread over the fields for manure, are now worth much to be devilled up and transformed into serviceable clothing; and the many noxious and nauseous substances formerly treated as nuisances—as they were—are now the very best substances out of which new creations are evolved. There is not a particle in the universe which deserves contemptuous rejection, and he is the benefactor, as he is the wise, who insists on ascertaining its utility, and making it available for the common good.

The specimens are in three sections, viz., vegetable, animal, and sewage and mineral waste. These we will condense for the purpose of attracting attention to the exhibition and its catalogue.

Cotton waste is a singular example of the successful application of scientific utilization. It is the collected sweepings of the card-room, and formerly had no value. Large heaps were suffered to accumulate until it fermented, and was then spread over the land. After that, cartridge-paper makers bought it at £2 to £4 per ton; then it rose in price, and means were found to bleach and tear it up, in order that it might be re-spun and woven, and now there is a trade of 14,000,000 cwts. giving employment to five hundred dealers. The various uses are all exhibited, and the refuse is then sold for engine-cleaning, and finally to the paper-maker.

Jute is next. An immense trade has been created. It is a product of Bengal, and formerly was used only for gunny bags to pack rags or merchandise in, but now it yields to processes which fit it for weaving with silk or cotton, or in the making of thread, ropes, sail-cloth, and with wool in flannels and carpets, and with cocoa-nut fibre for matting, &c. During twenty-five



DUPLEX PUMPING ENGINE.

years the consumption has risen from 391,000 cwts. to 1,250,000 cwts., and the value from £90,000 to £1,000,000; and the refuse now equals the original import of the raw material.

There grows around many seeds a soft down, especially in Eastern vegetation, which, from having no value, is now spun into a loose cord, and with cotton thread for a warp, now makes a very useful material. The application is of Eastern and African origin, where very large quantities abound; but we now import it for upholstery purposes, because of its softness, warmth, and cheapness, besides which, moth, &c., will not attack it. The trees of South America yield a similar substance, but much coarser, which is used for chair-stuffing, packing, and finally for rough paper-making. A very large family of this species of waste vegetable substances has not yet found money value, but every year competition brings some of them into the market, and by-and-by they will all find a useful place. Some of them are as soft as silk, and are used for stuffing best pillows, but as yet the quantity is not enough to employ special processes and machinery. The like remark applies to seaweeds, some of them having a fibre quite equal to silk, both in strength and softness, but the cost of collection and assortment hinders their usefulness.

Mosses are employed by the Russian distillers in the production of alcohol in large quantities; some from the islands of the Atlantic are used by dyers; in Sweden they construct door-mats, and in England hassocks and baskets from various kinds indigenous to those districts.

Nuts are substances rapidly increasing in their adaptation to our wants. Trees grow for their wood, and the use of the nut among civilized people is of modern date. The cocoa-nut comes from the palm, a wild tree which is now much cultivated, and there is no part of the nut that is not an article of commerce, but its service is of recent origin. The husk can be made up into a polisher for furniture, and into drinking cups, ladles, pipes, and buttons. The fibre makes a good substitute for horsehair; from it excellent mats of many kinds, some brown, some coloured in elaborate fancy patterns, are manufactured; it is even twisted up into yarns for ship uses, and the particles remaining are now used in gardens to protect plants from frost. Then the oil in its plain form is well known; it is the basis of nightlights, and the fruit is taken for oil-cake. Even the pine cone is of value. The French peasantry collect them for lighting their fires; the Italians have a scented one which they place in drawers to repel vermin; the Chinese one producing oil, and when roasted the seeds, like coffee, are eaten, and the waste is employed in stuffing hospital mattresses, because they destroy contagion. Vegetable ivory is from an American nut, and has many uses. It can hardly be deemed a waste product, except that the dust of it finds its home in the adulteration of bone-dust, or as an absorbent where oil is much used. The exhibition contains a large number of articles made of this ivory vegetable nut, and specimens of many other nuts used medicinally and for fancy articles.

But the cotton-seed comes more strictly under the designation of waste. From it, nevertheless, a dark crude, oil is pressed. Cake for cattle food is made, and the woolly kinds yield material for bed stuffing, and the waste goes to the paper-maker with the fibre of the husk. In distilling for the oils in cotton-seeds a residue remains from which a resinous pitch for coating submerged cables, or to make black varnish, is manufactured; and the further residue is bought by the asphalte makers for mixing with their material in the formation of roads or floors.

There are a score of nuts from which oil is made of different kinds, some for food, some for burning, and some for medicine, and the visitor finds much interest in their inspection.

We notice next the convertibility of grasses and stalks in modern manufacture. Straw is a well-known servant. Plaited, it is familiar alike in civilized and barbarous communities for hats, and in Japan and China for boxes and shoes; but its recent utility in England is in the manufacture of paper, for which several mills now consume an aggregate of 150 tons per week. The account-book makers use the straw-boards, which are composed of refuse straw and straw knots, mixed with earth. At Bethnal Green are many beautiful productions, such as picture frames, fancy designs, coloured plait sandals, &c. &c. made of rice, wheat, flax, or oat straws. But the straw of flax has a superior use because of its hempen nature; paper-makers like it for the strength and cleanness and the facility of treatment which distinguish it from other vegetable substances. The wild grass of Spain and Algiers—esparto—has made itself a great source of trade through the science and perseverance of Mr. Thos. Routledge. No longer wild, it is now a yearly crop duly cultivated and harvested, and is not confined to the paper-makers' demand, being used for cordage and matting. It must by-and-by find a still higher position because of the softness and length of its fibre. Then what shall we say of the bamboo? Scorned as a mere barbaric material for Indian canoes, it has become the recognized material for baskets, sieves, chairs, stools, matting, light rafts, cables for suspension bridges, aqueducts, arrows, musical instruments, and even its young shoots are good for food.

Wood has of late joined the fibrous community. Africa has large stores that are useless as timber, but are thoroughly fibrous throughout. The like may be said of some kinds in America and in the interior forests of Europe. From these excellent paper is made, and it is now being mixed with ordinary materials by the application of chemistry.

Then as we pass on, there are samples of wood dust—saw-dust. Jewellers buy boxwood dust; furriers, cedar and mahogany; dyers that of pine; manufacturing chemists, soft dust for oxalic acid; distillers, shavings to make brandy; stationers for cards; and upholsterers for stuffing mattresses, in which last Bauman's patent has developed an invention and discovery of great value, likely to supersede horsehair.

Barks are another class of waste in endless variety, in kind and use; medicine, manufacture, dyeing, rope-making, tanning, and many other channels are supplied thereby for special purposes. The refuse—tan—has not yet attained the market it must have. But cork has long been a marketable commodity, and its uses remain the same; the only addition being that the dust of the workshop is used in the compositions for floorings, and when burnt, for manufacturing black, in which it is aided by the ordinary burning of oils and tar to make lampblack.

Canes have been redeemed from wild uselessness to the service of man, and now by diverse methods enter into a hundred varieties of industry, baskets, lattices, walking sticks, umbrella ribs, matting, chair-making, &c.

The great mass of vegetable residue in its countless forms is available to the paper-maker: leaves, fragments, waste of factories, everything can, if quantity be provided, be converted by his art under the appliance of modern chemistry. Nothing really remains unavailable to the service of man.

Of animal waste the variety is less. Bones and their treatment we hope to describe in a separate article. The research of the chemist has been of immense service in the utilization of this important residuum of existence. Gelatine, knife-handles, manures, charcoal, ink, blacking, and food for animals are the results already obtained from this form of waste. Even blood is of great service; to the sugar refiner, and to others. Its refuse makes the richest manure; but before that is obtained composts of fat, and cartilage, and other materials are added, and an excellent food for animals is manufactured. These are all set forth in the collection at Bethnal Green.

Feathers form another important waste material that has grown into a regular merchandise, not so much in the ornamental descriptions, for they cannot be deemed waste, but from the odd fragments in the preparation processes, and in the ordinary purifying, and in the uses of down of all kinds; indeed, every farmhouse should collect every scrap of feather from the farm-yard and the poultry barn, for there is not a particle but is of value even to the quill; for from those which cannot be used for pens, toothpicks, camel-hair brushes, fishing tackle, and many things are made, and the thrift of its collection would have its reward.

The use of leather cuttings is interesting. When the tanner has the skins, he has many pieces quite useless to the leather-merchant to cut off. These are sold as glue-pieces, to size-makers and paper-makers; but apart from this, leather-dressers are compelled to skiver the skins in places to obtain some uniformity in thickness, and the substance thus removed had no use until lately. Now by a French method this is moulded into large pieces, and cut up for linings of shoes, and such other uses of leather as do not require the tenacity of the animal skin; but the invention is in process of development, and a way will be found to make such leather of equal service to the natural; and in some cases where a pattern is required, as in the sides of some books, very superior. There are several experimenters now engaged in this line of research and observation. Glue, gelatine, finings, &c., are produced from this species of waste, and it is rising into higher uses.

The waste of the silkworm has grown into importance. The cocoons, as we all know, contain a considerable quantity of silk, which the creature so gums over that they cannot be unwound, and if they could, being eaten through, were useless. These are not now useless. Silk has gone up in price, and it has been necessary to convert these cocoons, and now there are a hundred ways by which it can become a profit. Apart from that, there is a great residuum in the silk factory, and this is collected and machinery can comb it and prepare it for re-working and for making into twist, &c. These results are illustrated by numerous specimens sent from Messrs. Lister and Manningham, Bradford, and others.

Animal waste, such as bladders, gut, &c., have always been

merchandise. The changes of modern times have increased the uses and improved the preparation, as, for instance, in gold-beater's skin, for whose factory one London maker requires the portion of 10,000 oxen weekly for his requirements. And for modern machinery there is a heavy demand for bands and gut cord, which is of immense strength and flexibility. Nothing can equal it, and we need not be reminded that the musical profession is a large consumer of such waste for stringed instruments, an application as old as history itself.

The time will surely come when the term "vermin" will cease to be applied to rabbits and hares. To the former the food-market is indebted for 27,000 tons of meat annually, at a value of one and a half millions sterling, and the fur skin-market receives 30 millions of skins; and of hare-skins there are besides 2 millions yearly. These supply employment to 15,000 of the population, who are engaged in making gloves, hats, and furs, either in the assorting, or preparation, or both. The cheap muffs, boas, &c., are made of these when the dyer and his subordinates have spent thereon their art and labour. In these skins is a long kind of *hair* independent of the fur, and different of course; this is carefully collected and is employed in bed-stuffing, and, which is not generally known, it is used for weaving with cotton and silk. The work thus produced is stiffer by the introduction of this cheap substance. The Russians felt and varnish it for the purpose of a kind of papier-maché goods, which are very strong, durable, and light; its enlarged domain of use still further increases the supply of work for the service of man. The waste of the skin goes to the glue maker, who in fact derives the greater part of his raw material from the tanner's waste shavings of every kind, to make skins thin, to make them equal in thickness, to make them of one size and shape for especial purposes; these in all their variety and value render important and essential service, to the comfort of the consumer and the rewards of labour. Oils, hair, wools, fragments are thus redeemed from the dominion of nuisance, and become in the aggregate marketable articles that yield good profits.

Then we turn to the items of excrement and urine; from these the chemist, agriculturist, and manufacturers obtain alkalies, sal-ammonia and other salts, ammonia in large quantities and of various properties, besides other results not as yet developed. We waste the greater part of this immense source of wealth by what we are pleased to regard as exalted or refined notions of delicacy, and obedience to what we call propriety. These pervert the arrangements necessary for collection and conversion, and demonstrate the want of refinement and grace in men; for surely the notion must be felt to be as stupid as it is impious.

But when we approach the waste man once perpetrated in reference to the products of the sea, we may well be astonished. Eel-skins make whip-lashes and the fastenings for flails; sole-skins, fish-glue, clarifiers, and leather; fish-maws, isinglass; sharks' eyes, food in the East, and the sardine and pilchard, oil; waste sponge is carbonized to obtain iodine, and the general waste for chemical manures. From fish-scales come fish-glue, artificial flowers, and fancy dress ornaments; and all the refuse of the commoner species yield first-class manures, as also does the supply of cod's heads and fish-bones collected on the shores of fish stations, after pulverization. This last item yields 10,000 tons to the American market, and our Newfoundland and other fisheries, and the purchases from Norway might yield us an enormous advantage both in fructification and commerce. We have also porpoise-skins made into leather and laces. Cod-roe, properly treated, yielding 1*s.* and 1*s.* 4*d.* per lb., and for fish bait we use 35,000 barrels a year. In fact, the variety is countless, and so are the uses; still, the multiplied waste surpasses even that.

The great drawbacks in the utilization of waste have arisen chiefly from the impracticability of the schemes of those who have attempted to treat the subject. Of the bubble companies within our recollection, how many of them have been for guano in all sorts of mixtures, chemical factories of every sort, ammonia works past telling, and several other descriptions? As the intelligence of the nation extends its range, it must also its influence, and by-and-by local organization, in connection with the parish or the municipality, will take hold on all this department, and make the collection, assortment, and distribution of waste matters a great source of local government revenue. The subject is, of necessity, outside our province, being more political than individual. That it is practical none can deny—that it is practicable we are sure. Had local governments held the water, gas, and other matters affecting their several constituents, according to their respective circumstances, in their own hands the cry about local expenditure would not—could not have been heard: for the waste of a town would easily supply the wants of a town; and the waste ought to be the property of a district if it is held to be a legal nuisance, and liable to legal damages. W. S. C.

STEAM BRICK KILN.[1]

By Henry W. Adams, M.D.

THE object of this paper is to describe a new and improved process of burning a kiln of bricks, uniformly hard, without a salmon brick, or a blackened, or a glazed brick in the kiln, and in one-half the time, and with one-half the cost for fuel now required.

Bricks may be made by any of the known processes, but they are then only pieces of mud, and are not in this condition merchantable. They must be burned in order to be of any value. The comparative value of a brick made from our beautiful clay, depends upon its hardness and the brightness of its deep red colour. To develope these qualities a high, sustained, and uniformly distributed heat is necessary. Such a heat cannot be secured in the old kilns. The outside walls absorb a large portion of heat, and thus rob the bricks next to them of the heat necessary to burn them hard. The heat ascending from the fires passes freely from the top of the kiln into the air and is largely wasted. Hence more fuel is used to burn an old kiln than is needed, if it could be properly distributed and utilized. When the fires are first fed with coal the gases generated fill the top of the kiln more abundantly and raise the temperature of the bricks; soon the coal cokes, and the production of incandescent gases rising through the kiln is diminished. The superincumbent air, now no longer lifted from the top of the kiln by the ascending gases, settles down upon and insinuates itself between the top courses of the kiln, and cools them. Thus the top and sides of an old brick kiln produce a large quantity of salmon bricks. These bricks are worth in this market about seven dollars per thousand. They average about one-fourth part of the kiln. It costs just as much to dig the clay, to temper it, to mould and dry these bricks, and set, and burn and handle them, as it does to make hard stretchers and paving bricks, which are worth from sixteen to twenty dollars per thousand. Besides in an old kiln, only a small number of pressed bricks can be properly burned in the heart of the kiln. The arches, from necessity, are always overburned in consequence of prolonging the firing sufficiently to burn the top and sides of the kiln into respectable salmon. This is a fair statement of the case. The practice and skill of generations have failed to remedy these defects.

To burn any kiln of bricks uniformly hard, and of a deep red colour, three things, at least, are necessary:—

1. The necessary quantity and degree of heat must be made.
2. This heat must be equally distributed to and surround every brick in the kiln for the same length of time.
3. This heat must be held in the kiln, under a pressure greater than the outside air, so as to cause it to fill the entire honeycomb of the kiln, and wrap every brick, and burn the top and sides as quickly as the bottom.

If these conditions can be realized in a kiln, it is easy to see that an uniform result will be obtained. But, to do this, it is necessary that the kiln should be an oven. The heat must be made outside of the kiln proper, and driven into, and under it, by forcible jets of steam, in order to fill the kiln with the necessary heat, under pressure. The top must be banked down by at least two platting courses of burned bricks to hold in the heat. In an old kiln the draft is shut off by closing up the top so tightly; but in the new kiln, it is practicable to do so, because no dependence is placed on the natural draft.

For three or four hundred dollars an old brick kiln can be converted into one suited to the new process. Take, for example, a ten-arch kiln, built in the old style. To alter this, take out the grate bars and widen the ash pits to the width of two feet, and turn an arch over each, composed of fire bricks, and filled with pigeon holes about two inches square, to let the heat through under the whole bottom of the kiln. The floor of the kiln is levelled off, and the bricks to be burned are set directly on this floor, without arches. The kiln is set in the usual manner, and two platting courses of burned bricks are laid down on the top platting course of green bricks. They are left loose enough to let the water smoke escape, then tightened down when it has gone. The fire places are built in front of the old fire doors, on the outside of the kiln, and the grates in these furnaces are four feet long, and two feet wide, and are on a level with the old ash pits, so that the products of combustion are driven into the permanent and pigeon-holed arches, under the bottom of the kiln. Jets of steam, escaping from nozzles, three-sixteenths of an inch

[1] Abstract from a paper read before the Franklin Institute at the meeting, Jan. 19, 1876.

in diameter, are let into the furnaces, over the fire doors, under a pressure of about sixty-five pounds to the inch, sweeping over and across the burning fuel. They make a partial vacuum in the furnace next to the fire doors, and draw up large volumes of air to intensify the combustion. No smoke is left unconsumed. The white hot gases, and superheated steam are forced under the whole bottom of the kiln and made to pass up through the pigeon holed arches, and thence through the bottom of the kiln, and fill the interstitial spaces between the bricks.

The top platting courses being now closed up tight, the kiln becomes an oven, filled in every part with an uniform heat. A partition is placed in the middle of the length of each arch to prevent the two opposite blasts from acting against each other. The steam is superheated at the expense of the overheated arches and bottom of the kiln, and becomes a carrier to lift up the heat and circulate it through the upper parts of the kiln. To cheapen the cost for fuel and to produce a large volume of flame to help forward the process of burning and colouring the bricks, I surround my kiln with a half-inch pipe, from which branches, one-fourth of an inch in diameter, lead and look over an inch hole through the top of each furnace, to allow a small stream of crude petroleum, about as large as a needle, to fall down on to the red-hot coals and burst into flame. The jet of steam shooting over the fire door and through the furnace, draws in air and produces the most intense combustion, and supplies the entire bottom of the kiln with an abundance of heat of the highest and most uniform intensity. This great source of flame and gases enables the use of cheaper fuel and the substitution of fine instead of ordinary coal. The grates are plates of cast iron, four feet long, and two feet wide, perforated with small round holes, about three-eighths of an inch in diameter on the upper side, and half-an-inch wide on the under side, to let the ashes fall through without clogging. The fires are kindled with wood and large coal at first, and then the fine coal is gradually thrown on, and kept about a foot thick. The small stream of petroleum falling on to this red-hot bed bursts into flame, and the forcible jets of steam draw in the air for perfect combustion, and nothing can exceed the economy, regularity, and perfection of the heat thus produced.

It is this perfect regularity, and continuity of the heat produced by the furnaces, which render the burning of the kiln so easy and so perfect. There is no danger from the use of petroleum in this manner. Explosions can never take place with any hydro-carbon, without an admixture with its vapour of atmospheric air, or oxygen. When stored in air-tight pipes, it is just as safe as water.

It now costs from two hundred and seventy-five to three hundred dollars to burn a kiln of two hundred thousand bricks, while in the same sized kiln by my process, every brick can be burnt, and burnt hard, for one hundred and ten dollars, or fifty-five cents per thousand.

So far as I know I am the first who ever used steam in a brick kiln, to be superheated by the excess of heat in the arches, and bottom of the kiln, and to lift up this heat and distribute it in the upper parts of the kiln. My first patent for this use of steam was dated July 21, 1868. When this patent was examined by the United States Patent Office, it was found that the word steam had never been used in connection with a brick kiln in the world. This patent was taken out in 1868, in nearly every country in Europe. In the specification of the American patent, I say: "The life of my invention consists in a new method of producing, distributing, transporting, and retaining the necessary heat in all parts of the kiln, so as neither to overburn the bottom nor underburn the top, but to equalize the heat of both by means of a positive, reliable, and instantaneous power, to supply any desirable degree of heat to all parts of the kiln alike. This I accomplish by the accurate and positive manner of introducing air and steam into the fire places, the former to promote perfect combustion, and the latter to become superheated, at the expense of the overheated fire places and bottom bricks, and both to carry up caloric to be distributed and utilized in raising the topmost courses to a settling heat."

Another of my patents was dated July 20, 1869, and covered some additional details, such as the building of the fire places outside of a brick kiln, and the forcing of the products of combustion into the kiln by jets of steam. Amongst the claims was one allowed in this patent for the use of steam, and is in these words: "The arrangement of furnaces in a brick kiln, with jets of steam discharging into the furnaces, substantially as and for the purpose set forth." These patents were parted with soon after they were issued, but the parties holding the right so modified the disposition of the fires and introduction of the jets, that their kilns never worked satisfactorily, and the patent was generally regarded as a failure. Had the kiln been arranged as patented, with an upright draft, its success would have been perfect at the start. The control of the original patents has now reverted to me, and with a new patent, dated Nov. 23, 1875, there is secured every useful detail which experience has shown necessary to make the invention all that can be desired.

To show that these statements are supported by actual accomplishments, I will state that four kilns have been burned off this last fall, for this time with the upright draft, in accordance with the patents. These were small kilns, and were built at the Fish House Station, near Camden, by Mr. Richard D. Cox, on the yard of Mr. Reeves. All four of these kilns were burned in half the ordinary time, and every brick was perfectly hard. The last kiln is now standing for exhibition, full of bricks, just as burned off. There is not a brick in this kiln, including the top platting courses, but what is hard stretcher. It settled thirteen inches, and was burned in just forty-nine hours by a man who never burned a kiln of bricks in his life before.

A further corroboration of these statements will be found in the fact that Profs. J. P. Cooke, Jr., and E. N. Horsford, of Harvard University, examined and reported favourably on the operation of the process, while the Mass. Brick Co., of Cambridge, near Boston, have put the kilns into operation with great success. When we consider that one thousand of bricks is required, to each seven or eight inhabitants of our cities per year, and that over $1.00 per thousand in price, and $1.00 per thousand in quality, is saved by the new kilns, the magnitude and the value of this improvement are made comprehensible to the minds of all.

PORTABLE MACHINE FOR CUTTING KEY WAYS.

THE machine, of which we give drawings, is constructed to receive the block on which grooves are to be made, and support it between two jambs, the opening of which is determined and maintained by means of female screws taken on wormed rods. The file, which is to hollow out the groove, is brought into contact with the block, and its descent is regulated by the use of a small hand-wheel. A rotatory motion is communicated to it by bevel gear, at the extremity of which is the moving pulley, which makes 250 revolutions a minute. A special arrangement allows the whole apparatus to be moved horizontally along the axis of the groove.

Our third sketch represents half the size of the different sorts of grooves that can be made by varying the length. It is unnecessary to dwell upon the advantages which this portable machine is capable of affording, by ensuring the regularity and exactness required for this kind of work. *Revue Industrielle, Jan.* 18, 1876.

Practical Literature.

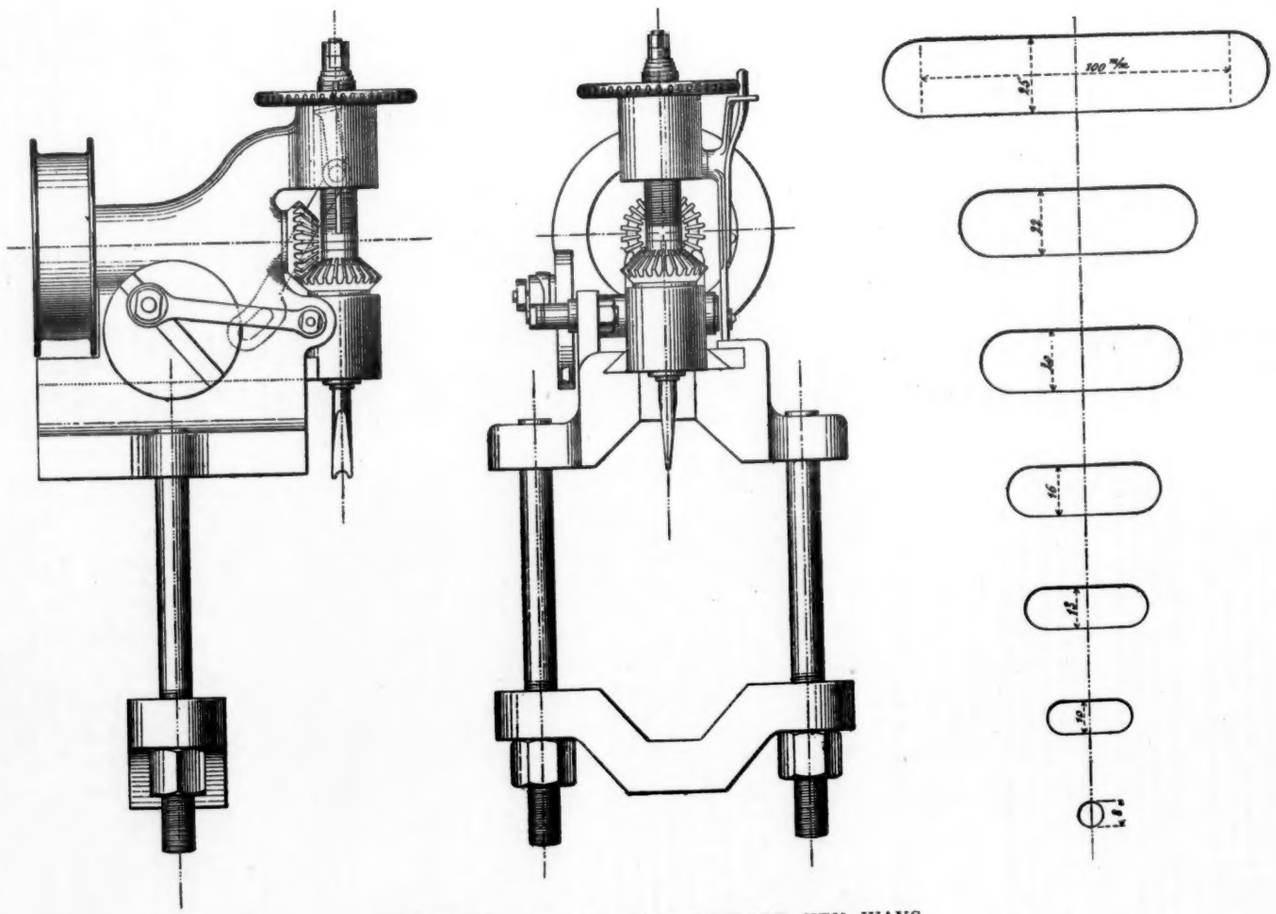
THE ELEMENTS OF BOTANY FOR THE USE OF SCHOOLS.[1]

THE science of botany has yet to be presented in a suitable form for young learners—although the subject is one to which increasing attention has been given within the last few years, and several new text-books have been recently produced. There is no doubt of the value of the study as a means of cultivating the observing power of children, outside of its own intrinsic importance. Perhaps the best effort to deal with the subject in this twofold aspect, is the work published a few years since in America, and recently issued in this country by Miss Eliza A. Youmans, of New York, entitled "A First Book of Botany."

We are aware that some English authorities have not spoken in high favour of the work, although it is warmly recommended by others, but our opinion of its value is based upon the observation of its utility as a teacher of the young, and we have reason to know that it is thought well of by some German scholars, while in America it is very largely used.

The work before us is modelled upon the old lines, and is a well-known and largely used school book in this country. It is sufficient to note here that it has now reached a third edition, apparently reprinted without revision from the original plates.

[1] *The Elements of Botany for the use of Schools.* By John Hutton Balfour, M.D., F.R.S.S., L. & E., F.L.S., &c. Third edition. Edinburgh: A. and C. Black, 1876.



PORTABLE MACHINE FOR CUTTING KEY WAYS.

AN ELEMENTARY TREATISE ON KINEMATICS AND KINETICS.[1]

THIS is a valuable contribution to our higher educational literature, in which the allied subjects of the geometry of a moving point's motion, and the causes and effects of motion in bodies, are dealt with in clear and well-expressed language, while the exercises and examples are complete and fully worked out.

The first part, on kinematics, deals with velocity, acceleration in its various forms, relative motion and instantaneous motion, and geometry of the cycloid. The second part is devoted to kinetics, and treats fully of the application of force to matter, so as to produce motion.

The work is intended primarily for the use of candidates for honours on the last three days of the mathematical tripos, and we have no doubt that it will also be found useful for students preparing for other examinations, where questions are set which may be treated without analytical geometry and the differential calculus.

THE TRADE MARKS REGISTRATION ACT.[2]

THIS is one of Wilson's series of Legal Handy-books, and as described by the author, who holds that "this Act is an instance of that mischievous quackery of our day—codification of the law," is an attempt to "explain the working of the proposed system, and to point out the worst defects of the act, which, unfortunately, are legion." We cannot here enter upon the great and much-vexed question of Patent Law Reform, but it will suffice to say that, notwithstanding our author's strong views against the present act, he has done good service in interpreting it clearly for those—and they are not few—to whom an act of parliament is as though it were written in another language than our own, and that the book is one which intending inventors, as well as holders of patents, should certainly procure.

A SHORT HISTORY OF NATURAL SCIENCE.[3]

THIS book, in addition to its special value and interest, of which we shall speak later on, seems to us to be of considerable importance, as indicating the enormous development of scientific literature in the present day. Formerly a scientific treatise, or, rather, an introduction to any particular science, was invariably prefaced by a retrospect of the course it has taken, and the history of its origin and progress; in a large number of such works which now come before us there is a growing tendency to discard this historical retrospect, and to plunge directly *in medias res*. Although we have more than once, in the newer books, regretted the absence of the few pages which took us back to the beginnings of the science, yet looking to the vast amount of material which the compiler now has before him in constructing his book, we fear there exists a real necessity for its omission. Now, however, if the young student prefaces his special and particular studies with a careful mastering of the contents of the admirable work before us, he will be fully prepared to take up the text-books provided for him, and he will not be an entire stranger either to their subjects or their terminology. The scope of the work is very clearly set forth in the title; the method adopted is a purely chronological one; the progress of the particular sciences in each era is dealt with separately, and is unfolded with great clearness and skill. Commencing with the science of the Greeks from B.C. 639 to A.D. 200, we learn how "by a patient study of nature, and by making real and careful observations and experiments," the Greeks "laid the foundation of much of the knowledge which we have carried so much further in modern times." We are next shown what were the discoveries made by the Arabs while all scientific movement had ceased in Europe, and finally we come to the rise and progress of modern science, which is dated from the sixteenth century. This section of the book is of course by far the larger, and although there is much that is interesting in the early portion, it is here that the value of the book chiefly lies, as affording the reader a glimpse of the fundamental principles of the different natural sciences, while revealing the various stages in their growth and development.

The author closes her work with the earlier years of the present century, and admirably summarizes the work of the sixteenth, seventeenth, and eighteenth centuries, in language which, although brief, is too long to be reproduced here. She shows how the vast mass of facts and experiments accumulated therein have been disintegrated, so to speak, in the present century, and special sciences, and special branches of a science have been made the work of a lifetime by individuals, while others have taken up "the separate facts collected by specialists, and have woven the whole of physical science into one grand scheme."

And here we must leave the work, but not without again commending it as a carefully compiled and admirably written book, giving a bird's-eye view, as it were, of the whole field of the natural sciences, from the earliest discoveries of the Greek philosopher down to the vast generalisations and minute investigations of the nineteenth century.

THE HABITATIONS OF MAN IN ALL AGES.[1]

MVIOLLET-LE-DUC is well known as one of the most fascinating writers on scientific subjects—always thoroughly sound, and never losing sight of the claims of accuracy of statement and precision of detail, his writings possess an attraction which is rarely met with in works which treat of kindred matters to those with which he deals. The work before us displays in a remarkable degree his knowledge, culture, and skill, and whether we read it for its interest as a narrative, its usefulness as an historical summary, or its value as a discussion of the principles of architecture, we cannot fail to derive real knowledge from its perusal. In it he describes the origin and development of domestic architecture among the various races of mankind, the methods in which human habitations have been constructed, the conditions which have shaped their character, and the appearance and manners of the dwellers therein, from the earliest times down to our own—exhibiting thus a complete view both of the growth of the human race, and of its knowledge and skill in this most important art—his object being primarily to elucidate its general principles, and thus to establish a sound basis for the education of the public taste.

The method which the author has adopted of unfolding this panoramic view gives an enhanced interest to the book. Epergos and Doxius, who respectively personify the spirit of progress, and that of obstinate adherence to traditional forms and habits, are the two imaginary witnesses of the development of architectural knowledge, whose visits to various parts of the earth at different epochs, and whose doings and sayings among men, are related to us in a skilful manner and in elegant style, although it has here and there suffered in the translation, notably on p. 12, where there is obviously some mistake: a sentence runs thus, "The thunder did not cease rolling but with a muffled sound." Generally speaking, however, the translation is excellently done, and the technical terminology is rendered with great accuracy. It is impossible for us to follow the wanderings of these two characters, or to enumerate the successive places and peoples which they visited, we must leave this to our readers, assuring them that they will not lay down the book for lack of interest, or because of difficulty in mastering the technical portions; these are illustrated by first-class engravings, which also convey an excellent idea of men, manners, and costume, and which make the work one of the most elegant of the season.

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[1] *An Elementary Treatise on Kinematics and Kinetics.* By E. J. Gross, M.A., Fellow of Gonville and Caius College, Cambridge, and Secretary to the Oxford and Cambridge Schools Examination Board. Rivingtons: London, Oxford, and Cambridge. 1876.

[2] *The Trade Marks Registration Acts, 1875. A Handy-book of the Law of Registration of Trade Marks, with plain directions for Registration, and a copy of the Act and Rules.* By John Pym Yeatman, Barrister-at-Law, author of "A History of the Common Law," &c. London: Effingham Wilson. 1876.

[3] *A Short History of Natural Science, and of the Progress of Discovery from the time of the Greeks to the Present Day, for the Use of Schools and Young Persons.* By Arabella R. Buckley, with Illustrations. London: John Murray, 1876.

[1] *The Habitations of Man in all Ages.* By Eugène Viollet-le-Duc. Translated by Benjamin Bucknall, architect, with numerous illustrations. London: Sampson Low, Marston, Searle, and Rivington, 1876.